PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE.

VOL. XXXVII.

JANUARY TO DECEMBER, 1898.

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AMERICAN PHILOSOPHICAL SOCIETY,

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VOL. XXXVII. JANUARY, 1898. No. 157.

Stated Meeting, January 7, 1898.

Dr. J. C. MORRIS in the Chair.

Present, 17 members.

Dr. T. J. J. See and Mr. Sydney Geo. Fisher, newly elected members, were presented to the Chair and took their seats.

Acknowledgments of election to membership were read from Messrs. Charles De Garmo, Arnold E. Ortmann, Thomas J. J. See, Alden Sampson, Sydney George Fisher, Benjamin Kendall Emerson, Francis L. Patton, Edward S. Holden, and Ethelbert Dudley Warfield.

An invitation was received from the Academy of Natural Sciences of Philadelphia, to participate in a memorial meeting commemorative of Harrison Allen, M.D., and George H. Horn, M.D., to be held at the Academy on December 31, at 8 o'clock.

The Judges and Tellers of the annual election reported the following officers elected for the ensuing year:

President.

Frederick Fraley.

Vice-Presidents.

E. Otis Kendall, William Pepper, Coleman Sellers.

Secretaries.

Persifor Frazer, I. Minis Hays, Frederick Prime, S. P. Sadtler.

Curators.

J. Cheston Morris, Benjamin Smith Lyman, Henry Pettit.

Treasurer.

Horace Jayne.

Councillors for three years.

Henry C. Baird, Isaac J. Wistar, Jacob M. DaCosta.

Councillor for one year, to fill an unexpired term.

George F. Edmunds.

Dr. I. Minis Hays was nominated for Librarian for the ensuing year.

Prof. Cleveland Abbe read a paper on "The Accepted Altitude of the Aurora Borealis."

Mr. Sachse and Mr. Cook offered some remarks in discussion.

Dr. T. J. J. See presented a paper for the *Transactions* on "The Evolution of the Stellar Systems," which was discussed by Prof. Doolittle, Prof. Snyder, Dr. See and Prof. Abbe.

The Society was adjourned by the presiding member.

THE ALTITUDE OF THE AURORA ABOVE THE EARTH'S SURFACE.

BY CLEVELAND ABBE.

(*Read January 7, 1898.*)

During the past three centuries numerous observers and physicists, astronomers and magneticians have endeavored to contribute to our knowledge of the altitude of the region whence the auroral light proceeds, and still the greatest diversity of opinion seems to prevail on this subject. Some observers have seen the light in such positions between themselves and neighboring objects as to demonstrate that the aurora, like the lightning, descends to the very surface of the earth and may even be entirely confined to the lowest stratum: prominent among these are Captain Parry, Sir James Clark Ross and Sir John Ross, his uncle, Dr. Walker and Prof. J. P. Lesley.

Others, such as Dr. Richardson, Sir John Franklin, Silbermann, have seen it so located among the clouds that its origin must be placed at or below their level and, therefore, within a few thousand feet of the earth's surface. On the other hand, those who have calcu-

lated the altitudes of specific beams and arches by trigonometrical or equivalent methods have generally found figures indicating altitudes between twenty and a hundred miles. Perhaps the highest altitudes that have been deduced were the following: Dalton, 150 miles; Loomis, 400 to 600; Bergman, 468; Boscovich, 825; Fournerius, 1006; Twining, 1100; Boller, 2000 kilometers, or 1243 miles.

Those who delight in numerical calculations accept these larger altitudes and content themselves with saying that the altitude of the aurora ranges from 50 miles upward to 1000. The experimental physicists, by studying the analogies between the auroral light and the discharge of electricity through vacuum tubes, have shown that the auroral phenomena harmonize in part at least with those observed in vacua such as might occur at moderate altitudes. Thus, Miller and De La Rue give altitudes of from ten to forty miles. Espy and Bache maintained that observers a few miles apart did not and could not have observed the same arches. The most careful observers have in many cases defended the accuracy of the observations made under circumstances that admit of no doubt that the auroral light in the free atmosphere often emanates from points within a few yards of the observer.

Lemstrom has sought to reconcile the diverse conclusions by maintaining that while many auroras are quite high up and belong to the upper air, yet those in extreme northern latitudes most generally belong to the lowest strata and follow the unevenness of the ground, appearing as glows around the mountain top, or as rays directed toward prominent objects.

The object of the present paper is to study some of the numerous observations, calculations and opinions bearing on the nature and the altitude of the auroral light. We shall not especially consider the electrical origin, or the source of the electricity, but simply acquiesce in the universal conviction that it really is one form of electrical discharge, our main object being to ascertain whether we can in any way definitely fix its *locus* in the atmosphere.

The most instructive method of procedure consists in taking up the consideration of a number of authorities in chronological order, by which means one is led to appreciate the slow progress of knowledge and the difficulty which many investigators have felt, from time to time, in giving up preconceived views without having anything better to accept in their place. There is nothing more diffi-

cult than to recognize the fact that all our ideas are wrong, and that we are wholly in the dark with regard to the nature of that which our eyes behold so plainly. How many thousands of years elapsed before modern science gave us any clue to the true nature of the rainbow, and how difficult it has been to eradicate from our text-books the crude ideas of Descartes, Huyghens and Sir Isaac Newton which made the rainbow to be a phenomenon of dispersion and substitute the correct view of Thomas Young, who showed it to be a phenomenon of interference.

Possibly we must go through a similar series of changes in our views with regard to the auroral light until we recognize that each observer sees his own aurora as a so-called optical illusion.

There are several forms of optical illusion that are evidently connected with the aurora. Some of these were recognized long since, while others are still deceiving our senses and perplexing our calculations.

As we pursue our reading chronologically, among the different authorities, we shall perceive how one after another is led to suspect and fully recognize some one or other of these optical or perspective illusions, while others, inattentive thereto, plunge deeper into misleading calculations. If, at the end of our consideration of the subject, we sum up all that has been shown to be probable or demonstrated to be true, we shall almost necessarily conclude that the determination of the altitude of the aurora is a much more delicate problem and perhaps also a more indefinite problem than we have hitherto believed.

After reviewing the literature of the subject since the time of Halley, we find that the methods of determining the altitude of specific features of the aurora may be enumerated as follows: (1) Parallax method; (2) Galle's first method; (3) Galle's second method; (4) Bravais' method of amplitudes and its modifications by Fearnley, Newton, Nordenskiold and Bergmann; (5) Bravais' method by the apparent breadth of the arch; (6) Bravais' velocity method; (7) my method, by the simultaneous motion of waves at the zenith and beams above an arch; (8) Gyllenskiold's method, by the apparent length of the auroral beam.

All these agree in one fundamental assumption, that the observed beams and arches have an individual existence and a definite *locus*. But this assumption is negatived by the equal frequency of negative and positive parallaxes whenever the parallax method is applied.

The only conclusion possible is that the observers do not see the same object, partly because the aurora is too low down and partly because there are optical illusions due to alignment. We are viewing a luminous sheet which is folded and refolded. We are also viewing a great collection of bright beams and bright pencils of light parallel to each other like the trees in a forest. Every slight change in the position of the observer alters the collective appearance of the pencils and the folds. The only method of determining parallaxes with any confidence consists in requiring two or more observers to start at the same point, fixing their attention upon one feature; separate to a short distance in opposite directions and return until they have satisfied themselves that the illusions due to perspective and alignment are not sufficient to nullify the influence of parallax.

Stated Meeting, January 21, 1898.

Vice-President SELLERS in the Chair.

Present, 14 members.

Mr. Alden Sampson, a newly elected member, was presented to the Chair and took his seat.

Acknowledgments of election to membership were received from Richard Olney, William H. Dall, Leroy W. McCay.

Mr. Rosengarten read an obituary notice of the late Treasurer, J. Sergeant Price, Esq.

Dr. Hays was elected Librarian for the ensuing year.

The appointment of the Standing Committees was referred to the President.

The following papers were presented:

For the *Transactions:*

Posthumous papers of the late Dr. Harrison Allen on

"The Glossophaginæ" and on

"The Skull and Teeth of the Ectophylla alba."

For the *Proceedings:*

"Specializations in the Lepidopterous Wing—Pieri-Nymphalidæ," by Mr. A. R. Grote.

"Description of Four New Species of Rocinela, with a Synopsis of the Genus," by Miss Harriet Richardson.

"An Old Broadside, with a Reference to the Throne of Congress," by Mr. Julius F. Sachse, which was discussed by Messrs. McKean, Rosengarten, Hildeburn and Sellers.

The meeting was adjourned by the presiding officer.

DESCRIPTION OF FOUR NEW SPECIES OF *ROCINELA*, WITH A SYNOPSIS OF THE GENUS.

BY HARRIET RICHARDSON.

(*Read January 21, 1898.*)

I.

The species of *Rocinela* here described were collected by the steamer *Albatross*, of the U. S. Fish Commission, during its various cruises in different localities. One of the species herein described comes from the Alaskan coast; another is from the coast of Cuba, off Havana, and the third comes from the southern part of the Gulf of California.

The new species exhibit unique characters not found in any other representatives. One, *R. cornuta*, has the antero-lateral angles of the first thoracic segment extended forward on each side of the eyes, but not touching them, thus giving the head the appearance of being immersed or deeply set in this segment. Another, *R. tuberculosa*, presents a row of small tubercles on the posterior margin of each one of the thoracic and abdominal segments of the body. In *R. cubensis*, the frontal margin of the head is greatly produced into a large rounded process with a concave surface.

The genus *Rocinela* is now known to include nineteen species,[1] of which nine were included in the monograph published in 1880

[1] *R. lilljeborgii* Bovallius (*Bihang Sv. Ak. Handl.*, 1885, Vol. x, No. 10, pp. 3–10, Pls. 1, 2) has been referred to the genus *Syscenus* Harger, and identified with *S. inflexis*, Harger's type species (G. O. Sars, "An Account of the Crustacea of Norway," Vol. ii, *Isopoda*, Pls. *iii*, iv, pp. 67, 68).

by Schiœdte and Meinert,[1] and the others in the order hereinafter noted.

R. danmoniensis (pp. 383–389, Tab. xi, Fig. 1).

R. insularis (p. 390, Tab. xii, Figs. 1–3).

R. dumerilii (pp. 391–393, Tab. xii, Figs. 4–6).

R. maculata (pp. 393, 394, Tab. xii, Figs. 10–12).

R. americana (pp. 394, 395, Tab. x, Figs. 16–18).

R. orientalis (pp. 395, 396, Tab. xiii, Figs. 1, 2).

R. australis (pp. 397–399, Tab. xii, Figs. 13–15).

R. signata (pp. 399–401, Tab. xiii, Fig. 3).

R. aries (pp. 401–403, Tab. xiii, Figs. 7, 8).

R. alaskensis (= *Æga alaskensis* Lockington). "Description of Seventeen New Species of Crustacea," Lockington, *Pro. Cal. Acad. of Sciences*, 1876, Vol. vii, Pt. i, p. 46, 1877.

R. vigilans. "On Some New Australian Marine Isopoda," W. A. Haswell, *Proceedings of the Linnean Society of New South Wales*, 1880, Vol. v, p. 472, Pl. 16, Fig. 2.

R. oculata. "Reports on the Results of Dredging, under the Supervision of Alexander Agassiz, on the East Coast of the United States, during the Summer of 1880, by the U. S. Coast Survey Steamer *Blake*, Commander J. R. Bartlett, U. S. N., Commanding," xxiii, "Report on the Isopoda," Oscar Harger, *Bull. Mus. C. Z.*, 1883, Vol. ix, No. 4, pp. 97–99, Pl. 3, Fig 2.

R. spongiocola. "Notes on Tasmanian Crustacea with Descriptions of New Species," George M. Thomson, *Papers and Proceedings of the Royal Society of Tasmania*, 1892 (1893), pp. 57, 58, Pl. 3, Figs. 3–8.

R. laticauda. "Reports on the Dredging Operations off the West Coast of Central America to the Galapagos, to the West Coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U. S. Fish Commission Steamer *Albatross*, during 1891, Lieut.-Commander Z. T. Tanner, U. S. N., Commanding," xxii, "The Isopoda," H. J. Hansen, *Bull. Mus. C. Z.*, 1897, Vol. xxxi, No. 5, p. 108, Pl. 3, Figs. 2, 3.

R. modesta., op. cit., p. 109.

R. cornuta, sp. nov.

[1] Symbolæ ad monographiam Cymothoarum, Crustaceorum, Isopodum, Familiæ," J. C. Schiœdte et Fr. Meinert, *Naturhistorisk Tidsskrift*, 1879—1880, Vol. xii, pp. 383–403, Pls. 10–13.

R. cubensis, sp. nov.
R. japonica, sp. nov.
R. tuberculosa, sp. nov.

II.

Analytic key of all the known species of *Rocinela*, with the addition of four new species.

a. Eyes contiguous.
  b. Head produced into process in front . . . *R. oculata* Harger.
  b'. Head not produced into process in front.
    c. Flagellum of second pair of antennæ as long as peduncle. . *R. spongiocola* Thomson.
    c'. Flagellum of second pair of antennæ more than twice as long as peduncle . . . . . *R. vigilans* Haswell.
a'. Eyes not contiguous.
  b. Flagellum of second pair of antennæ with 14–16 joints.
    c. Eyes close together.
      d. Head with frontal area excavated, bicarinated, front roundly produced with raised margin . . . . . *R. danmoniensis* Leach.
      d'. Head without median excavation, not bicarinated . . . *R. insularis* Schiœdte and Meinert.
    c'. Eyes widely separated.
      d. Propodus of prehensile legs with two to four spines.
        e. First thoracic segment with antero-lateral angles produced horn-like at sides of head . . . . . *R. cornuta*, sp. nov.
        e'. First thoracic segment normal.
          f. Frontal margin of head produced;
            g. Head tuberculated . . . . . *R. cubensis*, sp. nov.
            g'. Head not tuberculated.
              h. Head with frontal excavation.
                i. Front bicarinated. . . . *R. dumerilii* Leach.
                i'. Front not bicarinated . *R. japonica*, sp. nov.
              h'. Head without frontal excavation . . . . . *R. modesta* Hansen.
          f'. Frontal margin of head not produced.
            g. Terminal segment of body linguate; both branches of the uropods crenulate on their exterior margins.

h. Spots present on both sides of the fourth thoracic segment . . . . . *R. maculata* Schiœdte and Meinert.

h'. Spots wanting on fourth thoracic segment.

i. Spots present on fourth and fifth abdominal segment and base of terminal segment. . *R. alaskensis*[1] (Lockington).

i'. Spots wanting on fourth and fifth abdominal segments and terminal segment . . . . *R. americana* Schiœdte and Meinert.

g'. Terminal segment of body subtriangular; branches of uropods not crenulate on their exterior margins . *R. orientalis* Schiœdte and Meinert.

d'. Propodus of prehensile legs with five or six spines.

e. Increase in breadth of abdomen from base to fourth segment . . . . . *R. laticauda* Hansen.

e'. No increase in breadth of abdomen from base to fourth segment . . . *R. australis* Schiœdte and Meinert.

b'. Flagellum of second pair of antennæ with ten or eleven joints.

c. Tubercles developed on all the segments of the body . . . *R. tuberculosa*, sp. nov.

c'. No tubercles developed on body.

d. Terminal segment of body ornamented with a pair of narrow semi-lunar bands separated by a longitudinal stripe . . . . . *R. signata* Schiœdte and Meinert.

d'. Terminal segment of body ornamented with a very wide crescentiform band, from whose posterior border three large hastiform stripes project backwards. *R. aries* Schiœdte and Meinert.

Æga belliceps Stimpson (*Proc. Ac. Nat. Sci.*, Philadelphia, 1864, xvi, p. 155), is also undoubtedly a *Rocinela* and may even prove to be identical with *Rocinela alaskensis* (Lockington) in which case the proper name will be *Rocinela belliceps*.

[1] *Æga alaskensis* Lockington (*Proc. Cal. Academy of Sciences*, 1876, Vol. vii, Pl. i, p. 46, 1877) must be referred to the genus *Rocinela*, as it agrees in every respect with the characteristics of that genus. When identifying *Æga alaskensis* Lockington with *Rocinela*, I found in conversation with Dr. Benedict that he had already recognized this relation.

III.

Rocinela cornuta, sp. nov. Figs. 1, 2.

Length of body, two and one-quarter times its greatest breadth. Outline, oval; surface smooth, with scattered points of depression.

FIG. 1.—Head, × 1⅔.

Head subtriangular, having a medium excavation. Its frontal margin is produced forward in a long and broad projection, widely rounded at its extremity, and curving upward. Eyes large and situated at some distance apart. The first antenna reaches the anterior margin of the first thoracic segment; its flagellum contains six articles. The second antenna extends to the posterior margin of the second thoracic segment; its flagellum is sixteen-jointed.

The thoracic segments are subequal. The antero-lateral angles of the first segment are greatly produced and extend forward a little less than half the length of the head, including the projection. These antero-lateral projections of the first segment do not follow closely the lines of the head, but rather extend out straight in a direction which is parallel to that of the frontal projection of the head. The extremities of these projections are rounded. The epimera of all the segments point downward and do not extend beyond the post-lateral angle of their respective segments with the exception of the sixth and seventh ones.

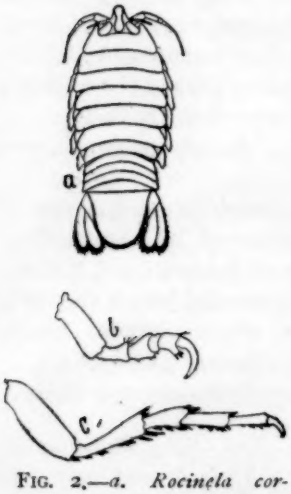

FIG. 2.—*a*. *Rocinela cornuta*, ♂, slightly reduced. *b*. Leg of first pair, × 4. *c*. Leg of fourth pair, × 4.

The first segment of the abdomen is almost entirely covered by the seventh thoracic segment. The last segment is rounded posteriorly and is faintly crenulate. The two branches of the uropods are similar in shape and size; the inner branch, being the longer, reaches the extremity of the abdomen. The uropods as well as the abdominal segment are furnished with hairs.

The propodus of the prehensile feet is armed with three spines,

and three blunt ones are found on the merus. The gressorial feet are long and slender and covered with spines.

Type.—The type specimen was found off Shumagin Bank, Alaska, Station 3338, 625 fathoms (U. S. Nat. Mus., No. 20086).

Rocinela cubensis, sp. nov. Figs. 3, 4.

Outline of body oval, surface smooth.

Head with rounded lateral margins. Its anterior margin is produced forward in a large rounded projection, whose breadth is equal to its length, and whose upper surface is deeply concave with upturned edges. This projection extends forward for about half its length and then upward, the change in direction being gradual. Eyes large and composed of ten rows of ocelli. Two small tubercles are situated between the eyes, and in the middle of the head and back of these is an arc-shaped depression. The first antenna reaches the posterior margin of the head; its flagellum contains six articles. The second antenna extends to the posterior margin of the third thoracic segment; its flagellum contains fifteen articles.

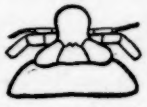

FIG. 3.—Head.

The thoracic segments are subequal in length. The epimera are long and narrow, with very acute posterior angles.

The first segment of the abdomen is almost entirely concealed by the last thoracic segment. The fifth is likewise covered at the sides by the fourth segment. The last abdominal segment is triangular in shape with a rounded posterior margin. The outer branch of the uropods is very broad and oar-shaped, with a rounded extremity. The inner branch is long and slender, of equal breadth throughout its length and rounded on its posterior margin. The inner branch is the longer one. Both are fringed with hairs.

FIG. 4.—*a. Rocinela cubensis*, ♂, × 2¼. *b*. Leg of first pair, × 4⅓. *c*. Leg of fourth pair, × 4⅓.

In the prehensile legs of this species the basis presents a row of tubercles on its superior margin. There are two spines on this propodus and three on the merus. The gressorial legs are but slightly spinulose.

Type.—The type specimen was found off Havana, lat. N. 23° 11′, long. W. 82° 19′ 6″, Station 2341, 143 fathoms (U. S. Nat. Mus., No. 20087).

Rocinela laticauda, Hansen[1] Fig. 5, 6.

Head, with a median projection, long and broad, extending slightly downward and having a blunt extremity. Eyes large, with ten rows of ocelli. The first antenna, with a flagellum containing six articles, reaches the posterior margin of the head. The second antenna extends to the middle of the second thoracic segment; its flagellum contains fifteen articles.

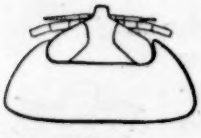

FIG. 5.—Head × 2½.

The thoracic segments are equal in length. The first is deeply bisinuated, its antero-lateral angles extending up the side of the head to about the middle of the eyes. The epimera of the second, third and fourth segments are rounded posteriorly; those of the remaining segments have pointed extremities.

The first segment of the abdomen is almost entirely covered by the last thoracic segment. The fifth segment, as well as this one, is narrower than the intervening segments, and not as broad as the base of the terminal segment. The last segment is widely rounded posteriorly and is fringed with rough hairs which almost conceal its crenulated margin; at the base it is impressed on either side of a keeled centre; the outer branch of the uropods is almost twice as broad as the inner branch; they are about equal in length. Both are fringed with hairs and indistinctly crenulate.

FIG. 6.—*a. Rocinela laticauda*, ♂, slightly reduced. *b.* Leg of first pair, × 4. *c.* Leg of fourth pair, × 4.

The prehensile legs are stout and short. There are four spines on the propodus and five on the merus, besides numerous hairs. The gressorial legs are likewise stout and furnished with spines and hairs.

[1] The description of the above species was written and the drawings made when Dr. Hansen's type specimen was returned to the U. S. Nat. Mus., and his manuscript sent to the press. As there are a few differences in the specimens, it was thought best to publish the new description.

The specimen described came from Alaska, off Unimak Island, Station 3225, 85 fathoms (U. S. Nat. Mus., No. 20088).

Distribution.—One specimen was found off San Luis Obispo Bay, California, Station 3195, 252 fathoms; one off Esteros Bay, California, Station 3194, 92 fathoms, and another at Puget Sound, Washington, Station 3067, 82 fathoms. The specimens from the coast of California are smaller in size and of very much lighter color than the other specimens. They are similar in other respects. Dr. Hansen's type specimen is from Acapulco, Mexico, Station 3418. It differs from the specimen herein described in the length of the second pair of antennæ, which extend to the middle of the third thoracic segment, while in the specimen we have described they extend only to the middle of the second thoracic segment; in the broader and longer terminal segment of the body, and in the increased number of spines on the propodus, and the decreased number of spines on the merus of the prehensile legs.

Rocinela japonica, sp. nov. Fig. 7–9.

Surface of body punctate and covered with black or brown dots. Color yellow, marked lightly in such a way as to present a mottled appearance. At the base of the terminal segment of the body, there are two small spots of brown, separated by a distance equal to half the width of the segment. Head subtriangular, excavated in the centre between the eyes and having the lateral margin in front of the eye produced into a lobe; the extreme front being truncate with rounded angles and curving slightly upward. The lobe in front of the eye extends half way between the eye and the extreme front. The eyes, which are small, are separated by a distance of half the width of the head. The first antenna, with a flagellum of six joints, reaches the posterior margin of the head. The second antenna, with a flagellum of fifteen joints, extends to the posterior margin of the second thoracic segment.

FIG. 7. Head, × 1½.

The epimera of all the segments of the thorax are acute, the posterior angles more rounded in the first two, but sufficiently pointed, in the remaining four. The epimera of the last two segments take a more oblique direction than the preceding ones, and extend laterally as far as the outer margins of the abdominal segments.

The first abdominal segment is almost entirely covered. The posterior angles of these segments are very acute and are produced

at the sides beyond the terminal segment and the basal joints of the uropods. The terminal segment is linguate and obscurely crenulate on its posterior margin. The internal branch of the uropods is somewhat longer than the external one, but the two are equal in width. They are both armed with spines on their outer margins.

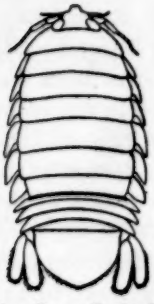

FIG. 8. — *Rocinela japonica*, ♂, × 1½.

The prehensile legs are slender. There are three or four hair-like spines on the propodus and five blunt ones on the merus. The gressorial legs are likewise slender and spinulose.

Of this species a single individual was found at Hakodate Bay, Japan, Station 3659, depth fifteen and a half fathoms (U. S. Nat. Mus., No. 20651).

This species is closely related to *R. modesta* Hansen. It differs from that species in the length of the first pair of antennæ, which extend only to the middle of the last joint of the peduncle of the second pair of antennæ, while in *R. modesta* Hansen they extend a little beyond the peduncle of the second pair of antennæ; in the greater development of the lateral margin of the head in front of the eye into lobes; in the excavation in the frontal area of the head; in the extreme front being directed upward; in the number of spines on the merus of the prehensile legs, five spines being characteristic in our species, three or four in Dr. Hansen's species; in the markings on the surface of the body of small black dots and the presence of two larger spots at the base of the terminal segment of the body.

FIG. 9.—Leg of first pair, × 3. Leg of fourth pair, × 3.

Rocinela tuberculosa, sp. nov. Fig. 10.

Surface of body punctate and marked with small black dots. The posterior margin of each of the thoracic and abdominal segments is lined with a row of tiny tubercles, above which is a row of small black dots.

FIG. 10.—*Rocinela tuberculosa*, ♂, × 2½.

Head subtriangular, rounded in front. Eyes large and situated at a distance of one-third of the head apart. The first antenna, with a flagellum of five articles, reaches the posterior margin of the head; the second antennæ extends to the posterior margin of the second thoracic segment; its flagellum contains eleven articles.

The posterior margin of all the thoracic segments is edged with a row of small tubercles. The epimera are narrow, those of the second, third and fourth segments being rounded at the top, while those of the last three segments are more acute.

The first abdominal segment is entirely concealed by the last thoracic segment. The second, third, fourth and fifth segments are likewise edged with a row of small tubercles. The last segment is widely rounded. The outer branch of the uropods is somewhat narrower and shorter than the inner one and is rounded at its extremity. The inner one is bluntly rounded. Both are fringed with hairs, and on their exterior margins are armed with spines. The prehensile legs have three long, stout spines on the merus and two on the propodus. The gressorial legs are covered with spines.

Two individuals of this species were found in the southern part of the Gulf of California, at Station 2824, eight fathoms, type (U.S. Nat. Mus., No. 20652), and Station 2828, ten fathoms.

SPECIALIZATIONS OF THE LEPIDOPTEROUS WING; THE PIERI-NYMPHALIDÆ.

(Plates I-III.)

BY A. RADCLIFFE GROTE, A.M.

(*Read January 21, 1898.*)

An immediate incentive to the present study is the statement, in *Evolution and Taxonomy*, that we find, in the Nymphalidæ, "an even greater specialization of the wings than exists in the Pieridæ." It may be premised that Prof. Comstock's classification unites in one family two seemingly distinct types under the term Nymphalidæ. Also that the neurational character given in the more recently issued "Manual" of the same author for the Pieridæ would exclude the Leptidianæ. The two wing types of the Nymphalidæ of Mr. Scudder and Prof. Comstock overlap. The Nymphalidæ proper, as I would limit the family, have vein iii$_4$ of the fore wings thrown off upon the external margin below apices throughout all the leading groups. But in the Fritillaries, which seems to be the most generalized group, there are genera, like Euptoieta, in which this vein reaches the apex, as in all the other brush-

footed butterflies. But, commonly, we can tell a Nymphalid from a Satyrid by this character. Again, on the hind wings, the Nymphalidæ proper show vein iv_3 entirely joined to the cubitus, and not issued from the cross-vein. In the Limnadidæ, Heliconidæ and Agapetidæ, which appear to form another branch of the "brush-footed" group of butterflies, this latter condition of vein iv_3 is only reached in a small group of specialized Satyrids, the Pararginæ. This character is plainly secondary, one which might occur independently in different groups not immediately phylogenetically connected.

The specializations of the lepidopterous wing, here chiefly considered, are visible among what I have called the "movable veins" and cannot be relied upon as decisive in general phylogeny. Their study leads to an arrangement of genera and species, in most cases upon a more positive basis, by supplying us with a gauge by which we may distinguish the younger from the older form. The norm by which these specializations are apprehended lies in the principle we have already set forth: the amount of the absorption is the measure of the specialization.

The two principal directions in which the specialization is manifested are: 1. the suppression of the media, common to both wings, and 2. the suppression of the branches of the radius, confined to the fore wings in most Lepidoptera and occurring sporadically. The latter is probably reminiscent of that action which has completed its task upon the hind wings of such Lepidoptera which have the radius already reduced to a single unbranched vein.[1]

Nomenclature.

The application of literary terms to structural groups, wider in extent than specific, has become uncertain through the publication of varying and subjective opinion. It has, therefore, become necessary to associate the generic title with a single specific type, ascertained by historical methods, in order to go safely. The failure to employ the name of the genus in this manner renders Mr. Reuter's recently published volume at times unintelligible. The same remark applies to Dr. Chapman's admirable paper on butterfly

[1] Consult, "Mittheilungen a. d. Roemer Museum," 8, February, 1897; "The Hind Wings of the Day Butterflies," Can. Ent., 29, 174; also several other papers more recently issued.

pupæ, where exactly what is meant by the terms "Satyrus, Epinephele, Hipparchia," does not appear (*Entom. Record*, vi, 152). So far as the diurnals are concerned the authority I recognize is Mr. Scudder's *Historical Sketch*, Salem, 1875. Since, in exceptional cases, this work has been seemingly properly corrected and even in one case by the author himself, a republication up to date would be one of the most grateful of literary helps to the systematist, to whom it is a matter of comparative indifference what term he uses so that it is correct and exactly conveys his meaning, while it should be one necessarily understood. Since the difference between genera and species is quantitative, the limitations of the former will be always more or less a matter of opinion. As matters are now and unless a standard is recognized, the object of nomenclature will be defeated so far as generic titles used by themselves are concerned. Both to give greater endurance to his work and to make it a useful addition to generic definitions extant in literature, the systematist might confine his studies to species used for generic types as far as possible and neglect those not yet so favored. To locate and compare genera their types need alone be considered; by clearly explaining the structure of these incidental help will be afforded to reach an approximative agreement as to the limitation of generic groups. Generic terms should always have the same meaning attached to them, and this meaning can only be derived from the structure of their types. I remember that Moeschler, disputing the validity of the genera allied to Smerinthus and wishing to discredit minute generic differentiation, asked triumphantly, To what genus, then, do the hybrids between species belonging to these different allied genera belong? A little reflection might have led him to ask the question also, And to what species? For although, to Moeschler, a genus would seem to have constituted a fixed quality, yet it is seen not to be so and that the genus idea is an extension of the species idea, and both ideal categories having a relative being without sharp outlines. In the formation of generic categories the idiosyncrasy of the describer comes easier to the surface, as in Mr. Scudder's genera; but for the purposes of the systematist these are as good as any, and better than most; all that is wanted being a certain name attached to a certain thing. The describers of species are the *avant couriers* of the systematists, one no more useful than the other, and any adverse criticism of the former class, who throw the first light upon our darkness, must be due to a lack of thought and considera-

tion. Nomenclature itself belongs to letters and is part of the machinery which biologists must use to work with. And we may remember here the fact that we possess no entire and satisfactory definition for the term *individual* as used in biology. So that it perhaps naturally follows that we are at a loss to define adequately groups or associations of which the individual forms the unit.

The following notes explain the changes made by me in

THE NOMENCLATURE OF THE PIERI-NYMPHALIDÆ.

Agapetidæ.—I use this term instead of Satyridæ because the generic title Satyrus Latreille is preoccupied (Scudder, *l. c.*, 265), and is properly replaced by the title Agapetes Bilberg, 1820 (*l. c.*, 104), with the same type, *A. galathea.* It is impossible to separate the name of a higher group from that of the genus upon which it is based. If Satyrus properly falls then Satyridæ must also go. But the type of Satyrus remains and the new generic title of this type by natural right replaces the old title in all its various modifications. It appears that the more modern title Satyridæ replaces the Satyri of older authors who antedate the Tentamen in the use of a plural form, thus in recognizing a group or family in our sense. In addition the term Oreas (Oreades) used by Hübner in 1806 is itself preoccupied. So that the claim of Agapetidæ to designate the family, with *Agapetes galathea* as its type, seems indisputable. Arge of Esper and also of Hübner would be preoccupied by Schrank (*l. c.*, 117).

Limnadidæ.—The earliest plural form applied particularly to a member of this group is Limnades of Hübner, 1806, based upon *Limnas chrysippus* as type. This must, therefore, replace the term Danaidæ of modern writers, a term based upon the later Danaus (*plexippus*) of Latreille, 1809, for which Scudder proposes to retain Danaida of the same author of 1805 (*l. c.*, 153), perhaps disputably, since Latreille's change seemed warranted at that time. Once a synonym always a synonym. In any case the modern Danaidæ cannot claim any connection directly with the *Danai festivi*, etc., of Linné, since that group had no legal standing; no genus of that name upon which it could be based having been published. Cuvier's similar use of "Danai" included also the Pieridæ (*l. c.*, 154), and, therefore, Limnadidæ has a clear right to recognition.

N. B.—I take the opportunity here to change my term Capis to Capisella since there is an earlier genus, Capys of Hewitson, which

interferes (PROC. AMER. PHILOS. SOC., xxxiv, 434). I also resume my name for *Lomanaltes lætulus*, since from the description it must be that Mr. Walker's species differs.

GENERAL DESCRIPTIONS.

These are limited to the holarctic fauna, of which the principal genera appear to have been examined. There remain, however, several types I have been unable to obtain.

Pieridæ. Pierinæ.—Primary wings, *specialization by suppression of the media:* Traces of the base of the media in the shape of scars I have found in Eurymus and Callidryas. In *Colias rhamni*, a mimetic form springing evidently from the same line, I fail to find the least impression. Backward spurs occur in Aporia and faint traces in Callidryas. The cell nowhere completely opens. The cross-vein becomes partially degenerate in a number of instances. In all the genera yet examined, vein iv_1, the upper branch of the media, leaves the cross-vein and is given off, outside of median cell, from the lower branch of radius. This character I only find again on the hind wings of Nemeobius. The middle branch of media leaves cross-vein above the middle and is radially inclined.

Primary wings, *suppression of radial branches:* End forms of specialization in this direction are offered by Mancipium, Pontia and Nathalis, where the five branches are reduced to three. The bulk of the forms: Pieris, Eurymus, Colias, Callidryas, Eurema, etc., are four-branched. As yet I find only certain of the Anthocharini, therefore the more generalized group, five-branched.

Secondary wings, *suppression of media:* Taking the homologies as given, the vein iv_1 assumes function and position of iii_5 on primaries; usually the piece between its base and the issuance of iii_5 from radius must be reckoned to cross-vein. The inauguration of the movement of the movable veins appears to take place on secondaries generally, since in a number of Lepidoptera vein iv_2 remains central on primaries, while on secondaries of same wings it inclines radially or cubitally. As on primaries, the cross-vein nowhere disappears in the Pierinæ and the cell remains closed.

Other features of specialization by absorption of veins: On primaries, vein viii is present, either as a scar or, in some instances, as an apparently functional, "tubular" vein. It takes the aspect of a short, oblique, more or less rigid piece, running from vein vii to internal angle. It has usually lost here the appearance of being

originally a longitudinal vein rooting in base of wing and, as in the Limnadidæ, appears more as a supporting strap. However, in Terias, where it is reduced, it assumes nearly the loop-like shape. The minute study of this vein is a matter of some difficulty. The appearance of vein viii in the Hesperiadæ corresponds essentially with that in the Sphingidæ and Saturniades, where it has the loop-like shape. These quantitative changes are probably correlated with mechanical function. On the secondaries of the Pieridæ, there are but slight differences in the amount of absorption of veins ii and iii at base; on the whole, the absorption is small and herein is the wing generalized. Vein i, the so-called "præcostal spur," is usually present; it vanishes in the Eurymini and in Colias (Gonepteryx); it may be seen in Callidryas. There is no equality of specialization, no exact and equal step in all these instances and the position of a genus or group can here not be assigned with certainty from any one character. Better, as a guide, is the radial specialization on primaries, where it may be laid down as an axiom that the five-branched forms cannot possibly have been derived from the three or four-branched, and that they are consequently descendants of older types and clearly more generalized insects. But neither may we group all the three or four-branched species together, since these specializations are reached upon what are otherwise evidently independent phylogenetic lines, in all cases necessarily succeeding a five-branched ancestor. Thus the three-branched Pontia is clearly an offspring from the five-branched Anthocharini; the three-branched Nathalis is more immediately connected with the four-branched Terias and Eurema.

Leptidianæ.—So different is this butterfly and so isolated its present position, that we must almost leave it out of sight in discussing the specialization of the Whites. The suppression of the media is nearly limited to the extinction of the basal portion. The position of vein iv_2 is central, or very nearly so, on fore wings, cubital on hind wings; we have here an exceptional parallelism with Papilio. The radius is generalized, five-branched. No trace of vein viii appears on fore wings. The median cells are small, retreating; the veins long. In comparison with the other whites, the wings are in a generalized state, but the chances are that in Leptidia (Leucophasia) we have a survival of what was a more extended group at one period and that the generalization is strictly relative. The disappearance of vein viii points in this direction.

A feature of generalization is offered by ii and iii of secondaries which appear completely separate.

Nymphalidæ.—This term is used in a restricted sense, equivalent to the Nymphalinæ of Comstock, or typical Nymphalids, apparently taken from Scudder.

Nymphalinæ.—Characterized by the position of i, ii and iii, of hind wings, which spring from one point owing to the fact that ii and iii are absorbed or fused up to the origin of i, which remains nearly constant in all the butterflies examined. This character is secondary in its nature and I have not yet studied the phylogeny of the genera fully. In this subfamily the suppression of the media reaches its widest extent and is only paralleled again in the Attacinæ. In the most specialized forms the cell entirely opens, all trace of the cross-vein vanishes on both wings. Vein iv_2 becomes radial. Vein iv_1 leaves upper angle of cell and does not fuse with radius.

Argynninæ.—Characterized by the fusion of ii and iii on hind wings not attaining the point of origin of i. No taxonomical features of neuration clearly define the minor groups, which are generally bound together by steps in the grade of specialization shown in the gradual suppression of the media. The "Goat Weed Butterflies" belong probably to the Charaxinæ, a specialized form having lost the "long fork" through absorption, but are not so specialized as the Nymphalinæ or "Purples," as might be inferred by their position in Comstock's *Manual.* In this work, as well as Mr. Scudder's, the sequence, as based on a specialization of the wings (and no other characters or class of characters allow of such fine distinction) is irregular. In the Check List of Dr. Skinner (1891) the disarrangement is nearly complete.

Agapetidæ (Satyridæ).—Wings (except in the Pararginæ) as in Pieridæ, but vein viii of fore wings entirely absent; vein iii_4 of fore wings to apex. The veins in many forms show a secondary sexual character in the enlargement of vein ii, the cubitus, or vii at base in male. This character is indicated in the Nymphalidæ, in Potamis and some Fritillaries and in the Ager.

Pararginæ.—The cross-vein of hind wings, or its traces, joins the cubitus; in other words the union of vein iv_3 with cubitus is complete, since this branch of the media has left the cross-vein. Here there is, in this apparently restricted group, a complete parallelism with the Nymphalidæ, from which the butterflies differ by

the position of vein iii_4 of fore wings. Cross-vein degenerate between iv_2 and iv_3 or cubitus, as might be expected, on hind wings, while on fore wings the specialization has not proceeded so far. Genera: Pararge and Lasiommata.

Agapetinæ (Type: *Agapetes galathea*).—Vein iv_3 of hind wings springs from cross-vein as in Pieridæ and next two succeeding families. All the North American genera I have yet examined (but many remain), and most European Satyrids belong here. The cross-vein is partially degenerate, but as long as vein iv_3 keeps its position and does not fuse with cubitus this may not here disappear. Vein i of hind wings varies in expression and, almost vanishing in Cœnonympha, is quite absorbed in Pyronia. It is diminished in Cercyonis. Probably its study may give us a better arrangement of the European forms. In Eumenis it terminates squarely as in the Pararginæ, and again in Nymphalis. In the other genera it is pointed. Owing to the inequality and slight nature of the specializations in the Agapetinæ, it will require a minute and patient comparison to straighten them out. Any rough classification or sequence attempted on "general principles" must be always nearly valueless. Œneis is evidently a generalized form.

Heliconidæ.—Study of the type: *Heliconius antiochus*. As in all the "brush-footed" butterflies, the radius on fore wings is in a five-branched generalized state, while iv_1 springs from upper corner of median cell. Cells completely closed, the cross-vein merely thinning a little below iv_2. No trace of vein viii, hence more specialized than Limnadidæ and agreeing with Agapetidæ. Vein iv_3 nearly central, a little radially inclined on fore wings and considerably more so on hind wings, where the cell is small, retreating, the veins long. Vein i determinate, pointed. The radius of fore wings is more specialized than in Limnas, where iii_2 leaves the stem opposite cross-vein. Here vein iii_2 arises beyond the cell. A more generalized wing than that of the Agapetidæ, more distinctly a Limnad type. All traces of the base of media disappeared; no trace of backward spurs from cross-vein.

Limnadidæ.—Study of the type: *Limnas chrysippus*. On the five-branched radius of primaries vein iii_2 springs from a point opposite cross-vein. Vein viii on fore wings present strongly developed. Veins strong; cells closed; a backward spur from cross-vein on fore wings opposite iv_2, the position of which is central. On hind wings this vein is slightly radial. Vein i of hind wings imperfectly

fused with radius at base; cross-vein angulate. The curious stigma below v_2 is attended by a rounded retreat of the vein, which is here slightly swollen. On comparing this type with that of Heliconius it is seen to be the more generalized. To separate Danaus from Limnas we must encroach apparently upon specific characters.

Libytheidæ.—Vein iii_4 to costa before apex; cross-vein partially degenerate; vein iv_2 on primaries central, on secondaries radial; vein viii of fore wings strongly developed as in Limnadidæ. Outline similar to Polygonia. On secondaries the cross-vein reaches vein iv_3 just immediately before cubitus. Specialization here almost like the Pararginæ. This isolated group, with its strongly developed labial palpi, cannot be referred to the stem of the Nymphalidæ proper (in *sensu mihi*) on account of the position of iii_4 and the presence of viii of primaries. It must be referred back on an independent line to the matrix from which the "brush-footed" butterflies originally sprang. It is now a specialized form as is seen by the extent of absoption of ii and iii, on hind wings, to the point of issuance of i, thus equaling the Pararginæ.

Nemeobiidæ.—Not a typical "brush-foot," but with the fore feet reduced in the male on the Riodinid type. Special examinations of this structure are needed to bring out the points clearly. Wings of the Pieri-Nymphalid pattern, not of the Lycæni-Hesperid. Radius five-branched, generalized. It is thus impossible to bring the butterfly into the Lycæni-Riodinid series in which the radius is specialized, three to four-branched, while the other neurational features contradict the supposition that it could represent a generalized type of the series. The neuration runs parallel with Libythea and the resemblances lie between this butterfly and Pieris. Vein iii_4 seems to join costa just before apex. Cross-vein entire, cells closed; on fore wings vein iv_2 is central, on hind wings radial. Vein viii of primaries seems to be degenerate and I represent it by dots in my original figure. Subsequent studies lead me to believe it wholly or partially tubular. Veins ii and iii of secondaries at base fused nearly to point of issuance of i, hence nearly as specialized as Libythea, much more so than in any Riodinid or Lycænid yet examined. When writing my original paper (in 1896) I failed to note that the family Nemeobiidæ had been recognized, though I have found no description and the study of the neuration seems to have been neglected. To unite this butterfly with the Lycæni-Hesperid branch appears to me a physiological impossibility. It

must rather be relegated to a distinct line, running parallel with the Libytheidæ and leading to the main stem of the Hesperiades. Its affinity with the Pieridæ is marked by the position of iv_1, which, on secondaries, has left the upper angle of cell and is fused with the radius to a point much beyond the median cell, as in the Pierinæ. Since there is a parallelism in the specialization between the Lycænid group and the Pieridæ in the reduction of the radial branches, a further parallelism might be made to account for this, especially as on primaries vein iv_1 is fused with radius as in the Theclinæ. But this will not explain the position of vein iii_3 on external margin, the radial position of iv_2 and the more unequal spacing. We might appeal to the imperfection of the geological record and conjure up extinct and intermediate series; but, independent of the fact that such flights of the imagination would lead us nowhere and would excuse even the arrangements proposed by Mr. Meyrick, we cannot do away with the main difficulty, that the wing of Nemeobius is developed upon the Pieri-Nymphalid pattern and that we should not logically graft it upon the Lycæni-Hesperid. The radius is also generalized, five-branched and cannot be derived from a three to four-branched group, which it should have preceded. But the five-branched Hesperiadæ are formed upon another pattern and could hardly have given rise to Nemeobius. The five-branched Hesperiadæ have most plainly produced the three to four-branched Riodinidæ and Lycænidæ. The wing of the latter is just what we might expect from a reduction of the radial branches of Hesperia. The conclusion we may come to is, that we should seek for the origin of Nemeobius in an independent line, and that the structure of the fore feet has been probably independently acquired. There is no difficulty in this, since aborted fore feet are also characteristic of certain moths belonging to the Hypeninæ, notably of *Pallachira bivittata* Grt. There seems to be a latent tendency in this direction which has broken out strongly in the day butterflies.

General Comparisons.

Before entering upon any comparison as to the amount of specialization in the Pieridæ and the "brush-footed" butterflies (=Nymphalidæ of Scudder and Comstock) it will be well to get a mental picture of the neuration of the Pieri-Nymphalidæ as a whole. This can best be obtained by contrasting it with that of an allied wing group in the same structural series, the Lycæni-Hesperidæ. Inde-

pendent of relative breadth or shape of wing we have in the latter a simpler pattern, the veins more equidistant, an indisposition to fuse and furcate shown by the retention of a central position by vein iv_2; so that as the suppression of the media takes its course this branch tends to degeneration *in situ*, from resisting the attraction of either radius or cubitus. As opposed to this we have a willingness in the Pieri-Nymphalidæ to preserve vein iv_2, which latter tends everywhere to become radial, except in the isolated case of Leptidia, where it becomes cubital. We have a spreading of the veins and abundant traces of unequal specialization. Except in the lycænid reduction of the radial branches, the Lycæni-Hesperiadæ offer few neurational changes to aid our formation of classificatory categories; the Pieri-Nymphalidæ plenty. United by the presence of the looping vein viii, or its traces unequally expressed and sometimes quite vanished, the Hesperiades offer in this way two groups characterized by the peculiar neurational wing pattern; giving us also an instance of parallelism in specialization, in that the Pieridæ sustain an analogous position with regard to the "brush-footed" butterflies (Nymphalidæ, etc.), to that the Riodinid-Lycænids show with respect to the Hesperids or "Skippers." In both these groups the reduction of the radius takes place; the Pierids still showing phases embracing and intermediate between the five and three-branched radius, while no five-branched Lycænid is yet known to me. Thus the gap in the Lycæni-Hesperiadæ between the subgroups is greater than that between the subgroups of the Pieri-Nymphalidæ. But the fact that the reduction of the radial branches has been independently taken up by the two main wing groups of the Hesperiades comes clearly out. I have been unable to find any characters which will always distinguish the neuration of the Hesperiades from the moths. Not so with the Parnassi-Papilionidæ, a distinct major division entirely left out of sight in the present studies.

Having thus endeavored to trace the outlines of the neuration of the Pieri-Nymphalidæ as a whole and to enable the reader to grasp more or less fully the wing structure of this waste of butterflies, we may more in detail compare the wings of the "Whites" with those of the other butterflies in their group. That the radius is specialized in the Pieridæ and generalized in all the other families is the first and obvious difference, one which strikingly throws the balance of specialization to the side of the "Whites." So that in this direction of secondary specialization, which the Pieridæ share with

the Parnassiinæ, the Riodini-Lycænidæ, as well as the Saturniades among the moths, the "brush-footed" butterflies (Nymphalidæ of Scudder and Comstock) as well as the Nemeobiidæ have no share and are *hors de concurs*.

We now come to the direction of the suppression of the media. Herein the Pieridæ lag behind the Nymphalidæ (*in sensu mihi*) with one remarkable exception in the position of vein iv_1, the upper branch of the media, which ascends the radius (iii_s) to a point beyond the cell, a character repeated only on the hind wings of Nemeobius. In all the "brush-footed" butterflies this vein never leaves the cross-vein at the extreme upper corner of the median cell. Though the latter open and the disappearance of the media by the distribution of its branches between radius and cubitus become complete, still vein iv_1 never fuses directly with the radius. Did it do so its passage to a point beyond the cell in the process of specialization might be logically expected to follow. What power is it which keeps this vein apart, even in Nymphalis and Potamis, where, in the latter especially, the approximation is carried out so completely? Undoubtedly all these retained and abandoned positions for the veins indicate the action of the dynamical force which fits the wing for variations in the mode of flight. The field observations which are compared with the structure of the wings are as yet scanty in the extreme. I have only brought the opening of the cell and the radial position of iv_2 into a probable relation with a lofty and sailing flight, a tree life like that led by *Potamis iris* or *Philosamia cynthia*. The passage of iv_1 along iii_s does not seem to help the wing to extended flights. We find it again in the moths, in the Smerinthinæ and Citheroniadæ. The bunching of the two upper branches of the media near the radius at this point seems, on the other hand, to strengthen the primaries. As these veins are retired from the radius and retain their original generalized position on the cross-vein, closing the cell, so does a more modest terrestrial habit of flight seem to prevail; so that it seems probable that the Lepidoptera were not originally high flyers, and that those which now disport among the tree tops are the latest arrivals on their respective and differing lines of phylogenetic descent.

To return to our immediate subject, the comparison of the specializations of the Pieridæ and Nymphalidæ proper. So far as the suppression of the media is concerned, the advantage of the Nymphalidæ is quite clear when the most specialized forms are compared, but

even when we descend to the "Fritillaries," where the cell of fore wings closes and vein iv_2 becomes quite central, the superiority is kept up. For everywhere on the hind wings of the Nymphalidæ does the lowest branch of the media, vein iv_3, completely fuse with the cubitus. The cross-vein above it is always very weak, and even vanishes in Araschnia, Melitæa or Euptoieta.

Leaving the two principal directions in which the movable veins show the effects of specialization, we can compare the Pieridæ and Nymphalidæ upon other points. The most important of these is the fusion of ii and iii upon the hind wings at base. Here the Nymphalidæ continue their advantage. In the Nymphalinæ the absorption extends even to the point of issuance of i, and this measure is attained in the most specialized of the Agapetidæ or "Meadow Browns," the Pararginæ. In the mass of the Nymphalidæ this excess is not reached and the point of absorption falls varyingly short. But still it is always carried to a further point than in the Pieridæ, where the union is very brief and apparently quite wanting in Leptidia. This character is plainly secondary and cannot of itself determine the phylogeny. Again, the amount of absorption of i may be compared, a vein which is relatively constant in its position upon ii, from which it issues. It did not always probably do so, for I have observed in Papilio, Zerynthia (=Thais) and Parnassius, the process by which it has come to be fused with ii, and in the present group traces of its independence may be found in the Limnads or "Milk Weed" butterflies. In the Pieridæ this vein i, the so-called "præcostal spur," tends to be absorbed and disappears in Eurymus (Colias) and Colias (Gonepteryx). Here the parallelism in specialization with the "Blues" is continued. But in the Nymphalidæ it appears everywhere to be strong and well-developed; it is here more generalized. Evidently the strong flight continued to call for a strengthening of the shoulder of the secondary wings. In the flutterings of the "Whites," the "Meadow Browns," the "Blues," this need was not so felt and the vein would tend to disappear.

So much we may say in comparing the Pieridæ with the Nymphalidæ proper, and we may pass more quickly over our comparisons of the "Whites" with the remaining families of "brush-footed" butterflies, the "Nymphalidæ" of Scudder and Comstock. After we leave the Pararginæ, the scale of specialization comes to a standstill or turns gradually against the latter. In the Agapetinæ, con-

taining the mass of holarctic forms of the "Meadow Browns," the lower branch of the media on the hind wings no longer fuses with the cubitus, but, as in the Pieridæ, springs from the cross-vein, the piece between this branch and the cubitus varying in length, and by so much marking here the grade of specialization. Except that vein viii of primaries seems to have been entirely absorbed in the Agapetidæ, it becomes difficult to distinguish their wings from the Whites. In both groups the position of the radial branches is similar. In the male sex the Agapetids show very frequently a bladder-like swelling at the base of ii, iii and vii of primaries, or the swelling may be confined more or less to the first-mentioned veins. In Agapetes it seems confined to ii; I do not find it in my preparations of Oeneis ællo, of which, however, I am uncertain as to the sex. It is a secondary sexual specialization, of which traces occur also in the Nymphalidæ. Like the Pierids, the Meadow Browns tend to lose vein i of secondaries by absorption; I believe, on the whole, that Pyronia represents the most specialized form. The amount of fusion of ii and iii at base still continues greater as against the Pieridæ, but hardly holds its own in comparison with the Argynninæ. In the Morphinæ, which appear to me to be specialized Agapetidæ, the cell opens on hind wings, but remains closed on primaries. They resemble thus the Pararginæ at present rather than the Agapetinæ, and have sprung apparently from the latter. Else, in our holarctic forms, the cell does not open on either wing, while it becomes, in the specialized forms, partially degenerate.

In the Heliconidæ and Limnadidæ the generalization makes itself more and more evident. The strong veining, closed cells, central position of iv_2 all tell against them. Heliconius still lacks vein viii of primaries, but in Limnas it is stronger than in any Pierid. At the close Libythea recovers somewhat of the lost territory, but this isolated butterfly, difficult to intercalate in a sequence, cannot probably alter the average result. Taking this all in all, we must find I believe that the excess of specialization in the direction of the suppression of the media, and in the subsequent points here explained, on the part of the brush-footed butterflies, as a whole, cannot outweigh the absence of specialization by reduction of the branches of the radius; seeing also that only in one family, the typical Nymphalids, is that specialization of the media carried to an excess. We have also the difficulty of estimating the morphological value of the shifting of vein iv_1 in the Pieridæ. While we cannot

thus assent to the conclusion expressed by Prof. Comstock in *Evolution and Taxonomy*, that we find in the Nymphalidæ an even greater specialization of the wings than exists in the Pieridæ, we admit that the point of view from which this is regarded may influence any conclusion, while the unequal presentation of the changes in the wings renders a just weighing of the differences a matter of some difficulty. It will be sufficient for my present purpose if the impression left on the mind of the reader is that rank is a relative conception and that it is owing to the constitution of our minds that we are impelled to string one natural object after another, while we are apt to fortify a classificatory preference for a special group out of several lying nearly abreast, by reasons which, sufficiently telling as far as they go, are apt to reflect only one side of a complex subject. I think, then, we may believe that the specialization of the "brush-footed" butterflies is more apparent in the feet than in the wings, and that, if we are not inclined to give them preëminence on that account in our sequences, we shall not be induced to do it upon the statement of Prof. Comstock herein discussed and illustrated.

Phylogenetic Lines Among Pierid Genera.

I have previously shown that coincidence in the number of the radial branches in reduction does not determine common descent, but that a three-branched condition of the originally five-branched radius has been reached independently, not only in different families, but on different generic lines within the same group. It may be assumed that three-branched species, differing otherwise unessentially, are correctly associated by this character; but to use this character anywhere alone for taxonomic purposes, or to assign it a commanding value, would be plainly to go wrong. It is probable, for instance, that the three-branched radius correctly indicates that the species of Thecla (*in sensu mihi*, with the type given by Scudder) are monophyletic and that the four-branched Zephyrini stand, at least constructively, as representing the original condition of their ancestors.

Under these views we may sort out several different lines of probable descent in the holarctic Pieridæ, in which the examples of extreme reduction have been independently developed. It is clear, since nature does not proceed by jumps, that the missing stages between the five-branched ancestors and the three-branched de-

scendants have existed and that forms, which have retained the intermediate character and thus represent an earlier condition, may yet be found and correctly identified. So that we must seek out forms whose main disparity consists in their respective state of specialization of the wings.

Referring to the accompanying phylogenetic table, we may commence our brief study with the so-called "Yellows." In Eurymus (Colias) the second branch of the radius has passed from its normal position before to one removed beyond the cross-vein. In Meganostoma this branch has only progressed to a point opposite the cross-vein. Clearly, Eurymus is the more specialized and younger form since this passage of iii_2 along the main branch of the radius is one indicated on different phylogenetic lines and is evidently a phase of general process by which the radial branches are reduced in number. The normal five-branched radius has this branch, following iii_1, before the cross-vein. Under this view Meganostoma is the representative of the primitive form of Eurymus. The "dog's head" pattern has probably yielded to the terminal band, straightly margined and the reappearance of the "dog's head" in species of Eurymus is due to "reversion." In other words, such species are the more generalized. But, while in the type, *hyale*, the distance which the vein iii_2 has traveled is a considerable one, it is much reduced in another species, *edusa*[1], which is more generalized in this way than *E. hyale*. From the multiplicity of species of Eurymus, especially in North America, it is not improbable that intermediate grades occur uniting the extremes *E. hyale* and *M. cæsonia*. I have not yet found them and Eurymus is yet separable from Meganostoma on this character. For purposes like the present study it is immaterial, so far as the use of the two generic names is concerned, whether such forms are found or not. The systematist needs both terms to designate different grades of specialization. The change in pattern involves a loss of black and not improbably does there exist a tendency, in the direction of specialization, to lose this and perhaps other darker colors upon the same immediate lines.

It is hardly probable that Callidryas is on the direct line of Eurymus, but it represents, in the holarctic fauna, an ancestral phase of development. It has the same four-branched radius, but vein

[1] Mr. Meyrick's figure of *edusa* (*Handbook*, 350) is too inaccurately drawn to be of service.

iii_2 has not moved at all from the original position within the cell. It is thus more generalized than either of its associates. From Callidryas-like ancestors may rather have sprung the curious form *Colias rhamni*, belonging to the genus Rhodocera, or again Gonepteryx of authors, but, according to Scudder, wrongly so referred.

In this genus in which the wings have probably been transformed by mimicry to copy the shape of a leaf, vein iii_2 keeps its original place of exit before the cross-vein; consequently it cannot have been derived from forms among which this vein was shifting. It must have been thrown off before Meganostoma-like forms appeared and probably Callidryas represents very nearly its direct line of descent. It is more specialized than Callidryas, not only in the remarkable shape of its wings, but because it has lost by absorption vein i of hind wings, the "præcostal spur" of some writers, which is still retained by Callidryas. The specialization runs in this respect parallel with the branch Eurymus-Meganostoma. In the latter genus a remainder of the vanishing vein i is to be seen which has become lost in Eurymus. The specialization on this phylogenetic line of the typical "Yellows" has not apparently developed a three-branched descendant, at least in the holarctic fauna, and so far as my studies now go. Nor have I yet found the five-branched generalized form, which might represent its more remote ancestry.

Turning to the next line of non-typical "Yellows," the Euremini, we find the three-branched descendant reached in Nathalis. This form has evidently emerged from four-branched ancestors, represented in America by Eurema and Terias, forms which so very nearly agree that I am even at a loss to distinguish them. I make out vein viii of primaries to be quite distinct and relatively strong in Terias, and conclude this may be the subspecialized form of the two. I cannot now connect this line with the typical "Yellows," and its ancestry must be apparently sought for in more southern regions.

We will now take up the "typical Whites." The three-branched condition is attained by *Mancipium brassicæ*. Here the little remaining branchlet iii_{3+4} of Pieris has at last vanished. But the vein iii_{3+4+5} in which it has lost itself is a little bent at this place. I should not wonder if examples of the "large Cabbage White" might be found retaining some trace of this vanished veinlet. In Pieris I have examined *rapæ* and *napi*, while Prof. Comstock's beautiful figure of protodice appears to agree (*Evolution and Taxonomy*, Pl. ii, Fig. 3).

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In all these the little vein iii_{3+4} remains distinct and has not been lost. Evidently Pieris represents the ancestral form of Mancipium and has perhaps been thrown off before the specialization of Pieris has progressed so far. Notwithstanding the similarity of the ornamentation I am not sure that *P. rapæ* is on the direct line of descent. As between *rapæ* and *napi* I incline to consider the latter at present the more specialized. *Aporia cratægi* is evidently a more generalized form, standing a little apart. Vein iii_{3+4} is quite a long furcation, and measures its distance from Pieris. The skeleton of the wing is more powerfully built and vein viii of primaries stronger than in Pieris, in which it seems little better than a scar. The gradation by which this vein, which appears usually like a loop, strap or support to vii at the base, passes into obliteration is so entire that the exact statement of its condition is often difficult either to correctly grasp or record. The "tubular" character disappears by minute gradations; the "scar" aspect and the "tubular" shape are easy to detect, but where the one commences and the other ends it is often hard for me to say. In the holarctic fauna I do not find any form to represent the probably actual five-branched condition of Pieris, but here several types are wanting to me which I should like to have examined. In the genealogical tree of the holarctic butterflies the more generalized Anthocharini must take the place of the common five-branched ancestor of the whole Pierinæ. But this seems to me to stand upon a separate immediate phylogenetic line of its own, notwithstanding some common features of color and marking. With this Anthocharid line we must now in concluding concern ourselves.

Among the Anthocharini, or what we may call the "non-typical Whites," we have, in *Pontia daplidice*, the attainment of the three-branched condition. This butterfly appears to me to have no immediate connection with the "typical Whites," but to be a descendant of Anthocharid ancestry. It is true that Mr. Meyrick refers it without comment to the genus Pieris (*Handbook*, 353), but it is also true that Mr. Meyrick, in the same publication, precedes Pieris by Leptidia (Leucophasia) and this again by Euchloe, and, to make the mixture complete, Gonepteryx (Colias). This sort of work appears to me to prove that Mr. Meyrick's studies are not yet sufficiently "correlated" with the actual facts of structure. If, indeed, the picture which Mr. Meyrick has received of the neuration at all resembles the figures with which his publications are adorned,

no proper judgment could, in my opinion, be formed upon it, and this would perhaps account in part for the seemingly extraordinarily unnatural sequences adopted by him.

The coincidence between the neuration of *Pontia daplidice* and that of *Mancipium brassicæ* is so great, that I am at a loss to give good characters of distinction. But showing, as I do, that the three-branched character of the Pierid primary wing is attained upon obviously distinct lines (*e. g.*, Euremini), this coincidence will not of itself determine the phylogeny. The shape of the wings and the pattern of ornamentation of Pontia are both Anthocharid. It is not conceivable how either could have been derived from Pieris and the "typical Whites." We should have to suppose that the four-branched Pieris threw off the three-branched Mancipium and also the three-branched Pontia; an inference which, considering the want of any near resemblance in the shape and pattern of the wings between the two descendants, or between one of these (Pontia) and the supposed parent stem, must be set down as untenable. More than this, we have in Pontia a similar secondary sexual character in the shape and extent of the wings to that we find in the Anthocharini, no trace of which is evident in Pieris or Mancipium. This character has evidently been retained by Pontia, through an ancestry of which I find one existing representative form, extending back to the five-branched representative of a remote phase which is brought before us now in Anthocharis and Euchloe. I believe that these facts show, that the phylogenetic position heretofore assigned to Pontia, is a discordant one and should be corrected. We may now leave Pontia and look over the more generalized and the typical Anthocharini with their five-branched radius.

Mr. Scudder (*Historical Sketch*, 113) says, regarding the use of the generic term Anthocharis: "As Euchloe must be used for the European species, *genutia* should be considered the type of this genus." This would seem to imply that all the European species were generically distinct from all the American and that the latter should alone be referred to Anthocharis. I do not agree with this statement at all, and I can show grounds for referring American species, with orange blotch in the male, to Euchloe, and for considering that the white species of both continents are slightly more specialized and might be kept under the separate title of Anthocharis. I regret not to have *genutia* to examine and I use Antho-

charis for the type *belemia*, which is, perhaps, identical. The subjective question of whether there are two "genera" to be considered is not of any importance to me at all. I recognize two five-branched types: the one specialized, which I seem warranted in calling Anthocharis under Boisduval's original use of that term; the other, relatively generalized, which I call Euchloe, with the type given by Mr. Scudder of *cardamines*.

The white Anthocharids differ from the type of *Euchloe cardamines* in that vein iii_2 has moved from the original position and is given off opposite, or even beyond the cross-vein. In *A. ausonides*, which is slightly the more specialized of the three examined, it has even passed the extremity of the cell for a considerable distance. Therefore the specialization runs here upon the same line as in the case of Meganostoma and Eurymus. The generic title Anthocharis should have, I believe, the type *belemia*, in case *genutia* does not share these essential characters and is not, in the sense here proposed, an Anthocharis. It is clear from the above citation from the *Historical Sketch*, that Mr. Scudder has misapprehended the state of affairs in this group; for I am quite unable to find any neurational differences between the North American *E. stella* and the European type of Euchloe. In both insects vein iii_2 retains its original position above the cell. And the chances seem to be that this will be the case with most of the species, carrying an orange blotch on the male primary, irrespective of locality. In any case, that which interests us here especially is the development of a specializing movement tending generally in the direction of a reduction in the number of the radial branches, but here taking a special and, looking through the day butterflies, perhaps an unusual direction. I find it, besides in these two instances, in the Pieridæ, in Euptoieta, Melitæa, Euphydryas, Araschnia and Heliconius. But when we examine Pontia, we find that, although the five-branched radius has become a three-branched, still vein iii_2 has not changed its place. The reduction has been effected by other means than the shifting of iii_2 in the direction of the apex of the wing. Into the details of the physiological process of absorption I cannot now enter, sufficient for my present purpose is the fact, that Pontia represents a clean descent from Euchloe-like forms and that it has not passed through Anthocharid-like forms upon its way. The absorption of iii_4 has proceeded to a varying extent in these species of Anthocharis. The little branch remaining has

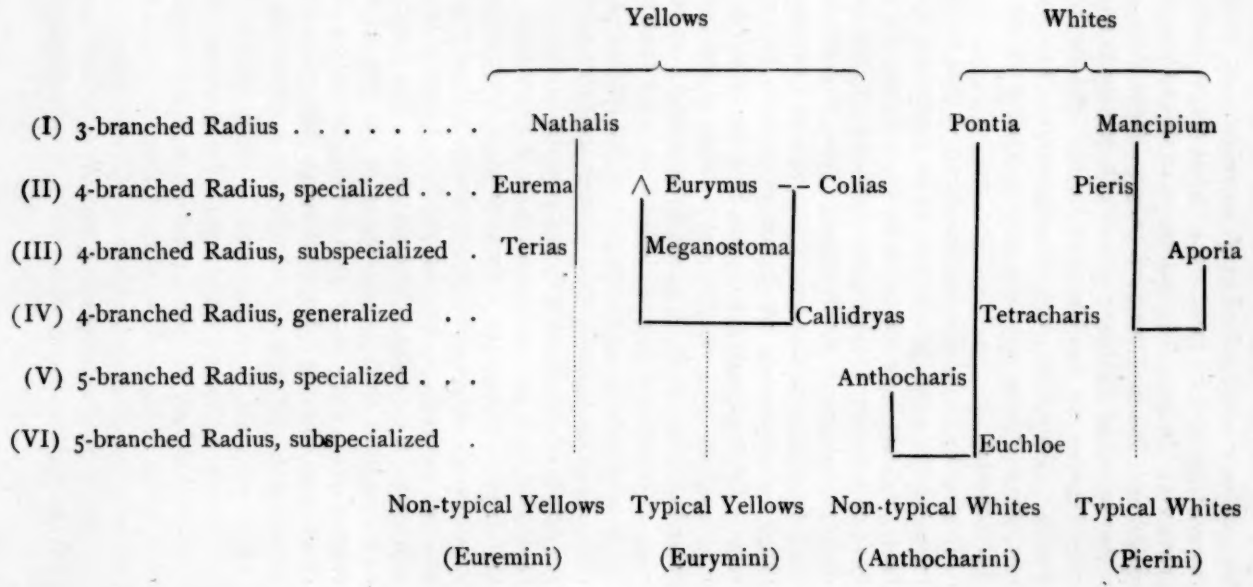
become very short indeed in *A. ausonides*. *A. belemia* would be the most generalized form, since iii_2 has not, or hardly, passed the cross-vein. In both *belia* and *ausonides* this halting place has been passed by. But in *Tetracharis* (n. g.) *cethura* Feld., sp., we have a four-branched Euchloe; one which represents an intermediate stage between the five-branched Euchloe and the three-branched Pontia. Tetracharis may be represented also by other species, since I have not been able to examine all the forms of the Anthocharini.

This survey of the Pierinæ has shown us that the Anthocharini represent the most generalized forms apparently in the holarctic fauna, and that they are probably the survivors, not on the direct line, of a former five-branched condition of the family. There remains one more five-branched form to examine: Leptidia (Leucophasia), but this presents so strange a neurational pattern, that it must have come into its present company by a vastly different route. Of its peculiar type it may be a specialized form, although, in comparison with the Pierinæ, it seems generalized. Its white color has come to it, I think, subsequently; as to its origin—*unde et quomodo*—I have no idea which is not imaginary.

To touch finally another aspect of our subject—a study of the dynamics of the butterfly wing has been somewhat neglected. From the details of the changes in the position of the veins, it may be concluded that the movements have a mechanical cause. Since this inquiry belongs to a department of direct observation upon which we can obtain absolute knowledge, without employing reconstructive methods, it may be painfully followed up, in field and cabinet, until the subject becomes clear. The butterflies certainly owe a part of their attractiveness to the fact of their seasonal appearance. They recur at a certain niveau in the biological circle, thus relieving the mind through their plain testimony from doubting that the principle of existence is succession.

TABLE OF PROBABLE TERMINAL PHYLOGENETIC LINES IN THE HOLARCTIC PIERINÆ.

(The differences in specialization are relative and unequal.)



The Charaxinæ.

The Nymphalidæ proper appear dichotomous. The main ascending branch is represented by the Argynninæ, running up into the Nymphalinæ. This branch is characterized by a short furcation of iii_4 with iii_5, and the genera may be called the "short forks." The second branch represents an earlier condition of the Nymphalids in which this furcation is more or less extended and the genera may be known as "long forks." Just as the passage from the Argynninæ to the Nymphalinæ by the continued greater absorption of ii and iii of hind wings may be considered to have gradually occurred, so the transformation of the "long forks" into "short forks" is inevitable by the progress of iii_4 toward the outer margin of the wing. But, other characters considered, the existing "long forks" seem to hold together on a distinct phylogenetic line. In Anæa we have an existing "long fork" which has lost its taxonomic character in this direction. In Euschatzia (type *morvus*) we have an allied Charaxid which still retains the character. Mr. Scudder having in 1875 (*l. c.*, 111) fixed the type of Anæa as *troglodyta*, this action could not be properly subverted by Schatz, who subsequently made the same species the type of his genus "Pyrrhandra," which name must fall. For *morvus*, more generalized than the species of Anæa, I choose the generic name *Euschatzia*. Genera like Aganisthos, Kallima and Anæa appear to represent in succession Consul, Charaxes, Hypna, Prepona, typical "long forks."

In Charaxes veins iii_4 and iii_5 fuse at base for a short space, only about one-sixth of the length of iii_5. If this short fusion were absent we should have a wing agreeing so far with that of Hesperia, that all the veins are separate, and no furcation, consequent upon the absorption of iii_4 by iii_5, has taken place. Thus in the primitive Nymphalidæ, represented more nearly by the Charaxinæ, the veins were probably all separate. And probably also in the whole group Hesperiades. In fact the hypothesis suggests itself that the lepidopterous wing may have originally shown a series of longitudinal and independent veins, connected by a system of cross veins and without furcations. The disappearance of the cross veins would allow of the contact of the longitudinal veins. This state of affairs would in turn lead to their partial absorption and consequent furcation. We may have in the Hesperiadæ and Tortricidæ existing stages of this evolutionary change in the lepidopterous wing.

To resume: Butterflies like Athyma and even Adelpha seem to find their natural place in the Nymphalinæ. But, when we come to the west coast of South America, we find in Megalura a form which shares the taxonomic character of the secondaries with the Nymphalinæ, while iii_4 of primaries reaches apex. Perhaps here we come upon a fresh phylogenetic line, and the meeting of i, ii and iii of the hind wings at one point is no longer a reliable index of a nearer blood relationship.

A Strange African Pierid.

A genus which has reached the grade of specialization of Nathalis, Mancipium and Pontia, and even gone beyond it, is represented by the strange little African butterfly *Gonophlebia paradoxa*. In his recent work Mr. Reuter has classified this butterfly as follows: "Papiliones: Pierididæ: Pseudopontiinæ: Pseudopontiidi: Pseudopontia." The major clamp in this declensional series—Papiliones—we can at once discard, since no proof has, nor apparently can ever be offered, that the Whites are phylogenetically connected with the Swallowtails. Further, if we may trust Mr. Scudder, the whole series of etymological changes must go by the board, since Pseudopontia is a synonym of Gonophlebia.

Two common butterflies will help us in understanding the venation of Gonophlebia: *rhamni* and *sinapis*. How the veins may be twisted to sustain the new shape of the wing, here assumed very probably under the influence of mimicry, is certainly taught us by *rhamni*, in which the branches of the radius are bent upward to sustain the expanded costa of primaries. Our strange African butterfly has the veins still more strongly bent out of their normal course to meet the required shape of its funny round wings. In Gonophlebia veins iv_1 and iv_2 have left the cross vein and spring, one following the other, from the main branch of the radius, vein $iii_3 + _4 + _5$, outside of the closed cell. This is an amplification of the usual Pierine movement of the upper branches of the median system of veins. This, not the whitish color, stamps Gonophlebia as an offshoot of the Pierid stem. Gonophlebia is even more easily recognized as a Pierid than *Leptidia sinapsis*, in which iv_1 has not left the cross vein. But, despite the contrasted shape of their wings, it is not impossible that Leptidia and Gonophlebia are isolated survivors of the same phylum.

The extraordinary movement of the middle branch of the median

series, vein iv_2, in following the lead of iv_1, proves Gonophlebia to be a highly specialized form. The neuration shows us that there is no contradiction offered to the view that Gonophlebia is a specialized Pierid and, in order to make this still plainer, we will study it a little closer.

What gives the pattern of the veining its singularity, and affords a faint reminiscence of the Pericopids, is the tendency to run apart which the veins display in Gonophlebia. The veins are bent more or less out of their usual course, and this is especially the case with v_2 on both wings. But all this effort is clearly exerted in order to sustain the circular shape of the wings and keep the thin membrane taut. On the secondaries the expansion of the rounded costal margin has to be performed solely by the radius, in its single specialized condition, without branches. And how is this infrequent task accomplished? The simple vein is bent upwards, near the middle, at a nearly right angle, supporting and anastomosing with vein ii; thence again, less abruptly descending, the radius runs outwardly to external margin below the apices, while vein ii itself is continued to the apex of the wing. Nature wished to make a spherical wing with no greater number of sustaining rods than go to support the longer wings of other butterflies, or even the narrow and extended wings of Leptidia. And thus, with the same economy of material, is the end attained. There arise no new veins, no complexity of machinery astonishes. We have the old veins in new position, but still showing the Pierine movement in specialization.

If Gonophlebia is the pattern of the veining so transformed, it is small wonder that Mr. Butler should deny and Mr. Scudder question its being a butterfly. Added to this the antennæ lack the regulation knob, which would allow Mr. Butler to place it among the "Rhopalocera." A puzzle to the classificators and a seduction to Mr. Reuter to a waste of category, this frail butterfly has evidently suffered many "vicissitudes of the voyage" along the road it has traveled and which may not be so very far now from its ending.

This strange butterfly is the only diurnal I have yet met with in which vein ix is retained on hind wings.

Explanation of Plate I.

The figures are obtained by combined photographic process. The veins are numbered according to the system Redtenbacher-Comstock.

iii = radius, iv = media, v = cubitus.

Fig. 1. *Pontia daplidice.* Type of genus. Attention is called to the three-branched radius. A specialized type. Vein iii_2 in original position.

Fig. 2. *Tetracharis cethura.* Type of genus. Compare the four-branched radius with the five-branched radius of Euchloe. Vein iii_2 in original position.

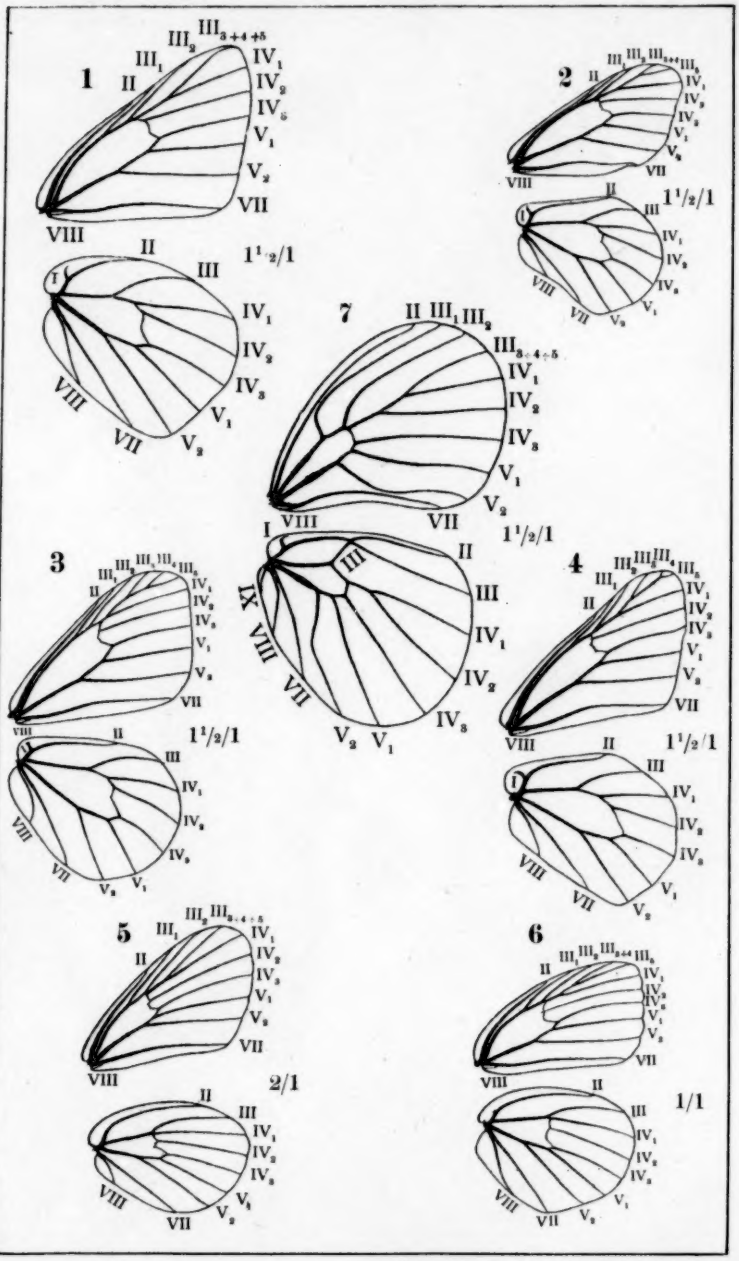
Fig. 3. *Anthocharis ausonides.* Vein iii_2 has moved forward to a point considerably beyond the cross-vein. Attention is called to the diminished extent of vein iii_1. A more specialized form than *A. belemia.* For this type Mr. Scudder uses Synchloe, but contrary to custom. The reason for rejecting Midea for genutia does not seem to me tenable.

Fig. 4. *Euchloe cardamines.* Type of genus. The five-branched radius shows vein iii_2 in original position above the cell. *E. stella* agrees. A generalized type of the group.

Fig. 5. *Nathalis iole.* Type of genus. A specialized type with three-branched radius.

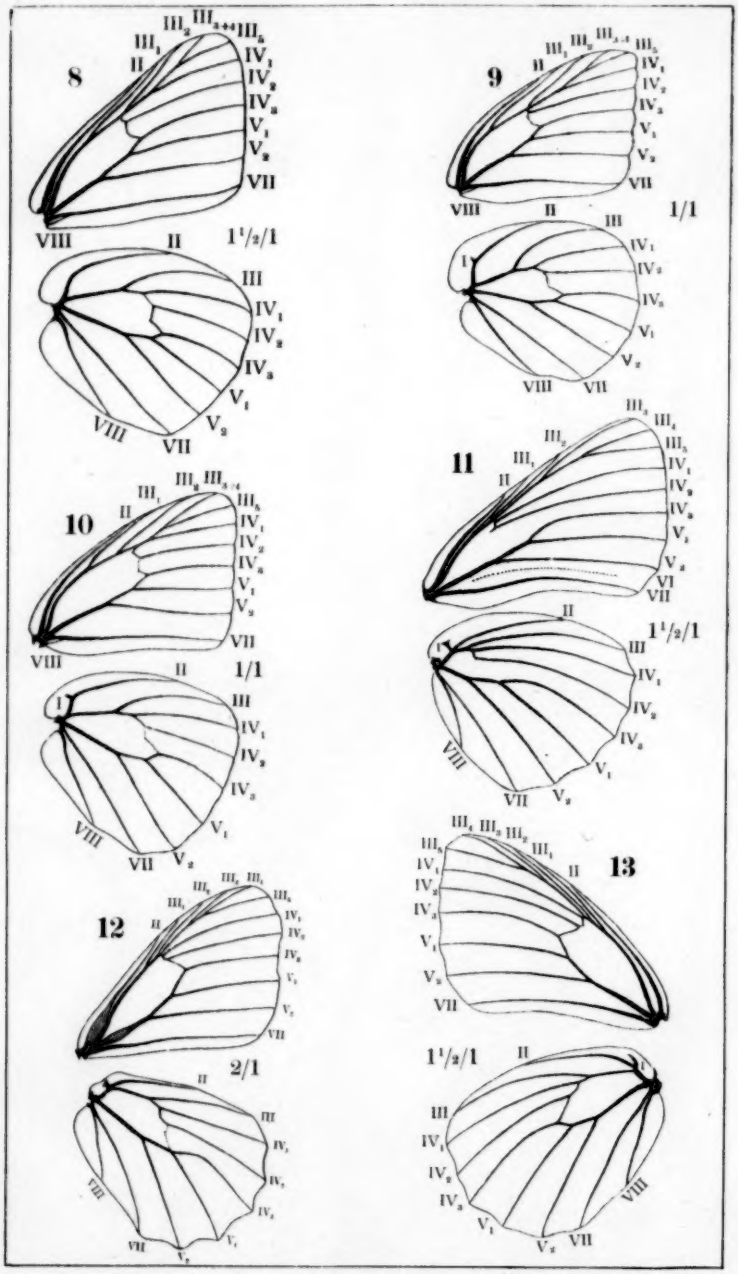
Fig. 6. *Terias hecabe.* Type of genus. A subspecialized type with four-branched radius. Vein viii of primaries fairly distinct. A mere rudiment of vein i of hind wings.

Fig. 7. *Gonophlebia paradoxa.* Type of genus. Vein viii of primaries present, short, close to vii. On secondaries three internal veins. Type of subfamily Gonophlebianue. Compare text.



Photolith. F. H. Bödeker, Hildesheim.

A. Radcliffe Grote — Wings of Butterflies.



Photolith. F. H. Bödeker, Hildesheim.

A. Radcliffe Grote — Wings of Butterflies.

Explanation of Plate II.

The figures are obtained by a combined photographic process. The veins are numbered according to the system Redtenbacher-Comstock.

iii = radius, iv = media, v = cubitus.

Fig. 8. *Eurymus edusa.* Attention is called to the slipping forward of iii_2. If a comparison is made with my figure of *Eurymus hyale* (*l. c.*, Fig. 7) it will be found that in this type of the genus the distance traversed by this vein along radius is slightly greater than in *edusa*, which is so far the more generalized form. A specialized type.

Fig. 9. *Meganostoma cæsonia.* Type of genus. Attention is called to the remains of i on secondary wings. On primary wing vein iii_2 halts opposite cross-vein. A subspecialized type on the direct line to Eurymus. Mr. Scudder prefers zerene for this genus.

Fig. 10. *Callidryas eubule.* Type of genus. A generalized four-branched type. Vein iii_2 in original position.

Fig. 11. *Nymphalis lucilla.* Type of family, subfamily and genus. Vein iii_4 given off upon external margin. Attention is called to the generalized state of the radius, common to all brush-footed butterflies. Also to the specialized condition of the median branches, which have joined the radial and cubital systems respectively. The cross-vein has vanished and the media, as a system, has virtually disappeared from the wing. Veins ii and iii on hind wings absorbed to point of issue of i.

Fig. 12. *Pararge ægeria.* Type of genus and subfamily. Attention is called to position of cross-vein on hind wings and to the fact that iv_3 has joined cubitus. Compare with the following figure in this respect.

Fig. 13. *Agapetes galathea* ♀. Type of genus, subfamily and family. A more generalized type than the preceding. The lower branch of media, vein iv_3, arises from cross-vein and is not permanently joined to the cubital system.

Explanation of Plate III.

The figures are obtained by combined photographic process. The veins are numbered according to the system Redtenbacher-Comstock.

iii = radius, iv = media, v = cubitus.

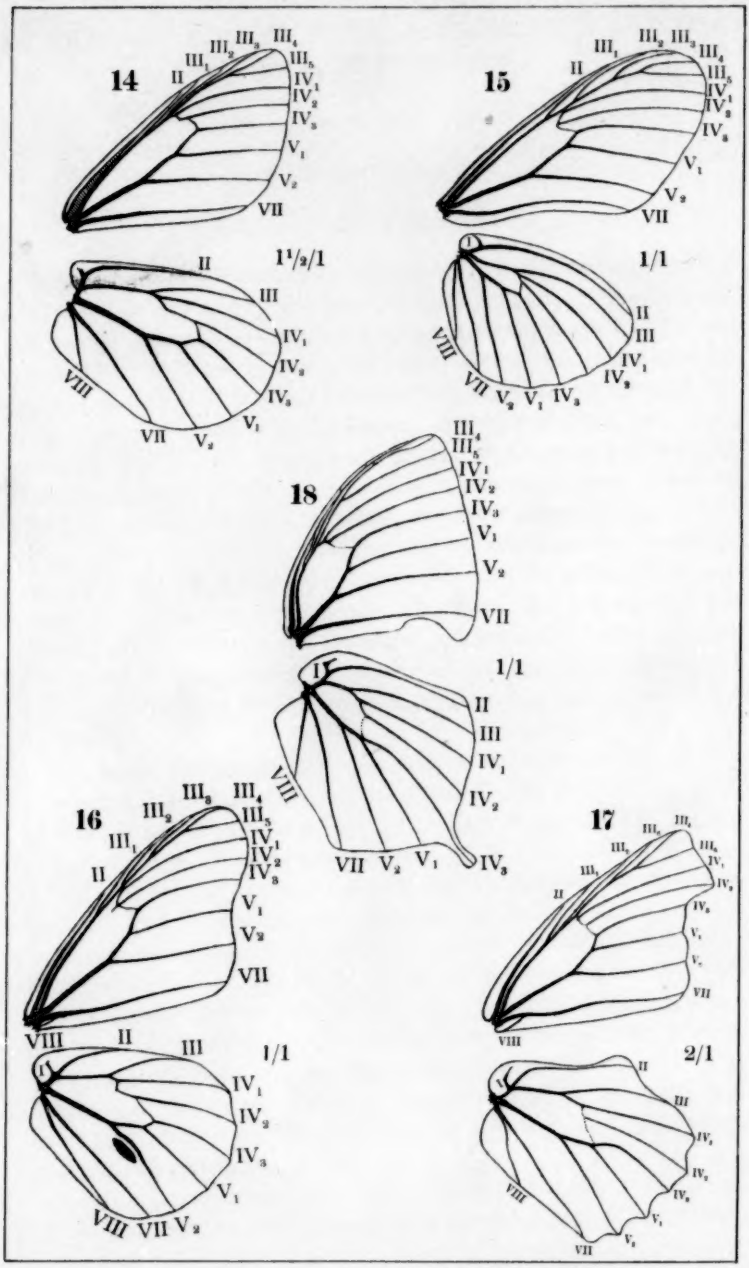
Fig. 14. *Oeneis norna.* Type of genus. Attention is directed to the fact that this is a more generalized form, belonging to the Agapetinæ with iv_3 from cross-vein, by the strongly closed cell and equidistance of the branches. The position assigned by Mr. Scudder, "at the head" of the brush-footed butterflies, cannot be a proper one. The genus seems related to Erebia (*l. c.*, Fig. 23).

Fig. 15. *Heliconius antiochus.* Type of genus and family. From its total characters a more generalized type than that of the Agapetidæ.

Fig. 16. *Limnas chrysippus.* Type of genus and family. Still more generalized. Attention is drawn to the strong condition of vein viii on fore wings.

Fig. 17. *Libythea celtis.* Type of genus and family. Outline of wings resembling Polygonia. Vein viii of primaries strong and position of iv_2 nearly central. In other characters specialized. ii and iii on hind wings fused to issue of i.

Fig. 18. *Euschatzia morvus.* Type of genus. The radial branches have intersected with subcosta. A long fork; furcation of iii_4 and iii_5 long, but shorter than in Charaxes. Compare text.



Photolith. F. H. Bödeker, Hildesheim.

A. Radcliffe Grote — Wings of Butterflies.

AN OLD BROADSIDE, WITH A REFERENCE TO THE THRONE OF CONGRESS.

(Plate IV.)

BY JULIUS F. SACHSE.

(*Read January 21, 1898.*)

A short time ago our efficient Librarian, Dr. I. Minis Hays, during his investigations among the miscellaneous property of the Society, discovered a bundle of old papers which bore the legend, "Of not much value." Upon opening the parcel almost the first paper examined proved to be a small German broadside over a century old. It was printed upon what is known as a quarto sheet, measuring seven by nine inches; it was without date or imprint, and the title simply told that it was a description of a silk serviette or handkerchief. Certainly not one to attract any special attention. Closer examination, however, showed that this advertisement or broadside was really the description of a fine specimen of the weaver's art, executed in silk damask or brocade, which had been made and distributed either in France or Germany, or perhaps in both countries, during the darkest days of the American struggle for freedom, with the express purpose of furthering America's interests in her battle for liberty.

The whole design appears to have been elaborate and symbolical, in which the portrait of Benjamin Franklin, Minister to the Court of France and President of the American Philosophical Society, occupied the most prominent position.

Diligent inquiry among scholars well versed in Revolutionary matters, both historical and pictorial, has failed in bringing to light any other notice of either the broadside or the allegorical handkerchief which was the basis for its publication; and it is but fair to assume that the printed sheet now brought to your notice, to say the least, is unique. The date of the making of our serviette, as it appears from the incidents and inscriptions woven in the fabric, must have been during the summer of 1778, evidently but a short time after the news of the British evacuation of Philadelphia reached the continent.

Another peculiarity of it is that it is couched in that peculiar kind of German, largely interspersed with French words and sentences,

which was prevalent in Germany at the period, when every petty princeling in that divided country aimed to maintain a court patterned after that of Louis XV of France.

We now come to the description of this symbolical relic as set forth in the broadside, and it is the fervent wish of the writer that this paper may be the means of bringing to light, or at least locating, one of these handkerchiefs of the Revolutionary period, should one have survived.

From the detailed description it appears that the handkerchief or serviette was of silk. In the centre was a rattlesnake, divided into thirteen parts, whereof the last part or tail end was supposed to be in a state of accretion, a prophetic allusion since realized. This symbol referred to the thirteen American Colonies then struggling for independence. It was patterned after one which appeared in Franklin's *Pennsylvania Gazette* as early as 1754, when he printed in his paper the cut of a severed snake and the motto, "Unite or Die," to show the necessity of Colonial union against the French and Indians. In 1775 this emblem was printed at the head of the *Pennsylvania Journal*, and the idea of the resemblance between the Colonies and the rattlesnake was often brought up in the literature of the day.

The name of one of the different Colonies appeared over each segment. The broadside further goes on to state that this peculiar reptile was chosen as the symbol of the new nation because it was held to be the noblest of its genus: it never strikes without first giving due warning to its enemies, and for this reason, says the broadside, it has been emblazoned upon the arms and flags of the American Provinces. The word *Provinces* evidently refers to such provincial flags as bore a rattlesnake upon their folds. The most noted one of this series was the celebrated flag of Paul Jones, with its warning motto, "Don't Tread on Me."

Within the circle formed upon the handkerchief by the segments of a divided rattlesnake was portrayed a large globe upon a pedestal, so turned as to show North America. Within the outlines of the continent was prominently displayed a portrait of Benjamin Franklin, Ambassador at the Court of France, beneath which appeared the legend, "The Wonder of Our Times." Above this portrait appeared the throne of Congress, together with the Book of the Law and a drawn sword, symbolizing the supreme power. Upon the pages of this book were inscribed, *Les Treize Provinces Unies*

(The Thirteen United Provinces) and *Indépendance le 4 Juillet, 1776* (Independence, July 4, 1776). In the foreground appeared a palmetto tree, upon both sides of which were placed the flags of France, to indicate the treaty so lately negotiated with that country.

A wreath of laurel formed the outside border of the handkerchief, to signify the reward of bravery. The four corners were interlaced with the lilies of France, which the broadside informs us also formed a part of the arms of the United Colonies. Here again we have an allusion to at least one of the many flags carried during the early part of the Revolution, prior to the adoption of the Stars and Stripes.

As corner-pieces there appear to have been four allegorical designs, whose chief *motive* were leading commanders in the armies of the United Colonies. The different Generals were supported by the goddess Minerva and surrounded by trophies of war and figures representing Prudence, Courage and Strength.

In the first medallion we have Washington; upon his left the god Mars who, with his sword, strikes off the shackles from a slave and announces to him emancipation, while he crushed under foot slavery and envy.

Upon Washington's right was Minerva, extending toward him a wreath of oak as an emblem of strength. Genius reclines at her feet and proclaims peace. The legend over this medallion, *Général Washington Il a peu d'Égaux en Bravoure, Prudence et dans l'Art Militaire*, informs the world that General Washington has but few equals in courage, prudence and the military art.

The second medallion shows a portrait of General Charles Lee. At his side are divers American prisoners of war bewailing their fate, and, pointing to the British arms, they implore Mars for succor. General Lee's late career is indicated by a dungeon upon whose walls are exhibited his arms, accoutrements and chains. The accompanying legend, *Général Lee, Tantot Vainqueur Tantot Vaincu*, signifies, "Betimes Conqueror, betimes Conquered."

The third medallion contains a profile of General Richard Montgomery. It is flanked by Sorrow, who points to an urn containing the ashes of the patriot. Below the portrait are seen a coffin and a monument. A mourning genius, with torch reversed, beside the cenotaph, represents death. Mars consoles him by pointing with his sword to a battle scene in the distance. The allegory is explained

by the legend, *General Montgommery,* [*sic*] *Thou do'st fall, but Freedom shall build her Throne on thy Grave.*

The central figure of the fourth medallion is General Gates, supported by Wisdom and Liberty, whereof the latter points with Mercury's wand toward the naval and military forces of the United Provinces. The fertility and affluence of our country are indicated by a scene on the river Nile. Above all appears the legend, *General Gates, Vainqueur de ses Ennemis* (General Gates, Vanquisher of his Enemies).

In connection with these four medallions there remain to be noticed four battle scenes ingeniously wrought into the fabric.

1. The battle of Quebec, where General Montgomery was killed. (*La Bataille devant Québeck, où le Général Montgommery fut tué.*)

2. The battle of Trenton, where the Hessian troops were defeated December 25, 1776. Curiously enough our broadside gives the credit for the victory to General Lee: *La Bataille de Trentvice, où les Hessois furent défaits par le Général Leé, le 26 Decembre, 1776.*

3. The battle of Saratoga, October 17, 1777, showing the surrender of Lord Burgoyne to General Gates. The legend reads: *La Bataille de Saratoga, le 17 d' October, 1777, dans laquelle le Général Bourgoyne fut fait Prisonnier par le Général Gates.*

4. The retreat of the British from Philadelphia by way of the Jerseys June, 1778. With the inscription: *Les Trouppes Angloises se retirent de Philadelphia à Jerseys l'an 1768* [*sic*].

Finally, there is shown a horizon with forked lightning, from which descend two crowns, each formed of thirteen parts, one divided, the other united; emblematical of the dependence and independence of the North American Colonies.

From the above description it will be seen that this specimen of the textile art was one of no mean order, either in its poetical conception or the artistic execution. It further brings to our knowledge a heretofore unknown means used to interest foreign people of the better classes in our favor during what may well be called the critical time of our revolutionary struggle.

Historically, our old broadside is of the greatest importance in one particular, especially so at this time, when the old State House and Independence Hall are undergoing another siege of "restoration;" our broadside gives us a definite clue to a representation of a hitherto forgotten or overlooked accessory to the furnishings of the east room of the State House.

Beſchreibung einer ſeidenen Serviette.

In der Mitte der *Serviette* zeiget ſich eine in 13 Theile getheilte Klapper-Schlange, wovon die letzte im Anwachſe iſt; ſie beziehet ſich auf die 13. vereinigte *Provinzen* von *Nord America*, deren Namen ſich um ſelbige herum befinden, und welche eben dergleichen Schlangen in ihren Wappen führen. Dieſes kriechende Thier wird in ſeinen Geſchlechte für das edelſte unter allen gehalten, weil es niemals etwas böſes thut, ſondern vielmehr ſeinen Feinde, durch ſein Klappern ſeine Gegenwart verräth.

Die Erdkugel, welche innerhalb des Bezirkes auf einen Geſtelle zu ſehen iſt, ſtellet *Nord America* vor; man erblickt daſelbſt das *Portrait* ſeines *Ambaſſadeurs* am Franzöſiſchen Hofe Hrn. *Doct. Frauklins*, mit der Unterſchrifft: Das Wunder unſrer Zeiten. Ueber dieſen *Portrait* befindet ſich der Thron des *Congreſſes* nebſt dem neuen aufgeſchlagenen Geſetz-Buch und dem Schwerdt, als welches die höchſte Gewalt vorſtellet. In dieſem Geſetz-Buch iſt auf der einen Seite zu leſen: *Les Treize Provinces Unies*, oder die 13. vereinigten Provinzen, und auf der andern Seite: *Indepéndence le 4. Iuillet 1776.* oder die Unabhängigkeit d. 4. Julii 1776. Im Grund erſcheinet ein Palmen-Baum, und an beyden Seiten die Franzöſiſchen Fahnen, als ein Zeichen des mit Frankreich geſchloſſenen Bündniſſes.

Der Lorbeerkranz, welcher den äuſerſten Rand der *Serviette* ausmachet; ſtellet das Bild der belohnten Tapferkeit vor, in deßen 4 Ecken man eine Franzöſiſche Lilie findet, welche einen Theil von dem *Nord Americaniſchen* Wappen ausmachet.

Die *Portraits* der 4 berühmten Generals, welche von der Göttin *Minerva* begleitet, und von den Siegeszeichen und den Figuren der Klugheit, der Tapferkeit und der Macht umgeben ſind, zeigen ſich innerhalb der 4 Ecken. Der Gott *Mars*, welcher ſich zu linken von *Washington* befindet, macht mit den Degen in der Hand die Sclaven von ihren Feſſeln loß, kündigt ihnen die Freyheit an, und tritt den Neid und die Sclaverey unter ſeine Füſſe. Der Göttin *Minerva*, die zur rechten ſtehet, und *Washington* mit einen Kranze von Eichen Laub, als dem Sinnbild der Stärke, krönet, ſitzet ein *Genius* zu Füſſen, welcher den Frieden verkündiget. Die Uberſchrifft über diſes *Portrait* lautet alſo: *General Washington Il a peu d' Egaux en Bravoure Prudence et dans l' Art Mili-*

tàire; oder das heißt: daß General Washington in der Herzhafftigkeit, Klugheit und Kriegs-Wissenschaft, wenig seines gleichen hat.

Das *Portrait* des General *Lee* erinnert uns an sein Gefängniß, welches durch einen Thurm bezeichnet ist, woran seine Waffen und Rüstung, wie auch seine Ketten angehefftet sind, mit der Ueberschrifft: *General Lee, Tantòt Vainqueur Tantòt Vaincù*, das heißt: General Lee, bald Ueberwinder, bald überwunden. Ihm zur Seiten befinden sich einige Amerikanische Gefangene, welche sein Schicksal beklagen, und *Mars* hierüber zureden, indem sie nach dem Englischen Wappen hinweisen.

Das *Medaillon* des General *Montgommery* im *Profil*, ist von der Traurigkeit begleitet, welche auf die Urne hinzeiget, worinn die Asche dieses großen Mannes aufbewahret ist. Ueber ihn folgen die Worte: *General Montgommery Thou do'st fall, but Freedom shall build her Throne on thy Grave*, oder: du fällst, aber auf deinen Grabe wird die Freyheit ihr Thron bauen. Unter dem *Medaillon* siehet man dessen Sarg, und zur Seiten deßen Grabmal. Ein dabey stehender traurender *Genius* mit einer umgekehrten Fackel, stellt den Tod vor; *Mars* tröstet ihn, indem er auf die daneben stehende Schlacht mit dem Schwerdt hinzeiget.

Das *Portrait* des General *Gates*, ist von der Weisheit und Freyheit umgeben, wovon letztere mit dem Stabe des *Mercurs* auf die See- und Landmacht der vereinigten *Provinzen* hinweiset. Der Nilfluß zeiget die Fruchtbarkeit und den Ueberfluß des Landes an, mit der Ueberschrifft: *General Gates, Vainqueur de ses Ennemis*, oder: der Ueberwinder seiner Feinde.

Die auf dieser *Serviette* gezeichneten 4 Schlachten, sind annoch zu bemerken:

Erstens. *La Bataille devant Quebeck où le General Montgommery fût tué*, oder die *Bataille* von Quebeck, woselbst der General *Montgommeri* getödtet wurde.

Zweytens, *La Bataille de Trentvice où les Heſſois furent défaits par le General Leé le 26 Decembre* 1776. oder die *Bataille* von *Trentown* wo die Hessen den 26 December 1776 geschlagen wurden.

Drittens siehet man die *Bataille* von *Saratoga*, den 17. October 1777. in welcher General *Bourgoine* durch General *Gates* zum Kriegsgefangenen gemacht wurde, mit der Unterschrifft: *La Bataille de Saratoga le 17.e Octobre* 1777 *dans laquelle le Géneral Bourgoyne fût fait Priſonnier par le General Gates.*

Viertens, die *Retirade* der Engländer aus *Philadelphia* und nach denen *Ierſeys* 1778. mit der Unterschrifft, *Les Trouppes Angloiſes ſe retirent de Philadelphia à Ierſeys l' an* 1768.

Endlich erblicket man auch zwey unter einen blitzenden Himmel in 13 Stück getheilte, endlich aber in eins zusammen gebrachte Kronen, welches die Abhängigkeit und Unabhängigkeit von *Nord America* verstellet.

I allude to the canopied throne in Independence Hall, a piece of ornamental furniture occupied by the Speaker of the Continental Congress at the time when Independence was declared, and which remained a feature of the historic room until some time after the Revolution.

Nothing can be farther from our idea of the birth of American liberty than the introduction upon the scene of a throne with royal emblazonment. The mere suggestion would seem like a desecration of our most cherished sanctuary, where assembled the noble patriots who declared these Colonies free and independent. It certainly does seem like an incongruity to picture John Hancock, him of the bold signature, descending from a throne or anything that savored of monarchy to affix his autograph to the immortal Declaration.

No painting or engraving, so far as known to the writer, portrays anything like such an accessory to the equipment of the chamber. No artist appears to have had the temerity to give us a true view of the Chamber of Assembly, with its gallery for the public and the ornate trappings over the windows and Speaker's chair. The memorable scene of signing the Declaration is generally depicted as one of extreme republican simplicity, in fact painfully so, giving the generations of the present day the impression that the interior of the State House, the finest public building in the Colonies, was as plain and devoid of ornamentation as a Quaker meeting-house, and in every case, as it now appears, incorrect in most vital detail.

Now, in the face of the accepted pictures of the Chamber of Assembly, or east room of the State House, we here have the statement of a picture of this throne, or, as it is called, "The Throne of Congress," supported by the Book of Laws and the Sword. And this picture appears as described on the handkerchief.

Unsupported by corroborative evidence, this statement would most likely, in the absence of the original, be received as a piece of artistic or poetic license on the part of the artist who sketched the design, and who for purposes of his own inserted a symbol of royalty so distasteful to patriots of all nations.

I will now read a piece of evidence in support of the existence of a throne in the east room. It was written by an eye-witness, the Prince de Broglie, who visited the State House in 1782:

"The State House, where Congress assembles, as does the Council of Pennsylvania, and where also the Courts of Justice are held,

is a building literally crushed by a huge massive tower, square and not very solid.

"Congress meets in a large room on the ground floor. The chamber is large, without any other ornament than a bad engraving of Montgomery, one of Washington, and a copy of the Declaration of Independence. It is furnished with thirteen tables, each covered with a green cloth. One of the representatives of each of the thirteen States sits during the session at one of these tables. The President of the Congress has his place in the middle of the hall upon a sort of a throne."

Now the phrase, "sort of a throne," might mean nothing, if coming from a modern American, more than a very dignified seat; but, coming as it does from a French nobleman of the ancient *regime*, it certainly suggests the idea of regal state. The least we can expect from it would be an ornamental chair on a dais surmounted by a canopy and ornamented with the symbols of the home government.

With these facts before us we may well assume that the symbol was an actual and not a typical one, and that it could only have been introduced into the general design by one familiar with the old Council Chamber.

We now come to another phase of the subject; how so elaborate a piece of furniture happened to be a part of the equipment of the Chamber at the time when the Continental Congress took the step which eventually made the Colonies an independent nation. The solution of this problem is comparatively easy. When it is taken into consideration that the room in which Congress met had for years been used by the Assembly of Pennsylvania, and was more or less elaborately equipped with fine furniture and hangings, there can be but little question that ample provision was made for the august Speaker and for the Governor when he was present on State occasions in the shape of an elaborate canopied dais, surmounted by the royal arms and other insignia of monarchical authority.

A somewhat similar arrangement with royal insignia over the seat of the Chief Justice ornamented the west room. The final disposition of these symbols of kingly authority appears in the issue of the *Pennsylvania Journal*, Wednesday, July 10, 1776, where we are told that on the evening of Monday, July 8, the day upon which the Declaration was publicly read, "Our late King's coat of arms was brought from the hall in the State House and burned amidst the acclamations of a crowd of spectators."

A throne with royal arms in Independence Hall! Words could hardly express a greater incongruity. Yet, to be historically correct, the learned Committee who have charge of the restoration of Independence Hall if they wish to place the ancient Chamber in the exact condition it was in on July 4, 1776 (and I believe that is the intention) will certainly have to introduce a canopied dais or throne in the eastern end of Independence Hall.

Another apparent historic incongruity in our old broadside is the legend which gives to General Charles Lee the credit for the capture of the Hessians at Trenton, when, as a matter of fact, that General was then a prisoner of war in the hands of the British. The explanation of this curious statement is that Lee claimed to have sent Washington the necessary information from New York, and formulated the plan of battle which brought about the capture of Rhal's forces. This, it appears, was believed in Europe to have been the case, and the design was evidently made and published before the news of the battle of Monmouth and the subsequent court-martial of Lee reached the continent.

In closing this paper I repeat the wish that its dissemination may bring to light, either at home or abroad, one of these symbolical compositions so curiously wrought in threads of silk and used in the interest of American Independence, the only description of which, so far as known, is the broadside found in the archives of the American Philosophical Society. Further, the finding of one of these serviettes would give to us the true design of the Throne of Congress, which for years was a feature of Independence Hall.

Stated Meeting, February 4, 1898.

Vice-President SELLERS in the Chair.

Present, 12 members.

Acknowledgments of election to membership were received from Profs. C. F. W. McClure and Henry B. Fine.

The Standing Committees for the year, appointed by the President, under resolution of the Society, were announced, as follows:

Finance.—Philip C. Garrett, William V. McKean, Joel Cook.

Hall.—William A. Ingham, Joseph M. Wilson, Horace Jayne.

Publication.—Daniel G. Brinton, Persifor Frazer, I. Minis Hays, Frederick Prime, Samuel P. Sadtler.

Library.—Edwin J. Houston, Frederick Prime, T. Hewson Bache, Albert H. Smyth, Samuel P. Sadtler.

Michaux Legacy.—Thomas Meehan, Angelo Heilprin, William Powell Wilson, Burnet Landreth, Henry Trimble.

Henry M. Phillips Prize Essay Fund.—William V. McKean, Craig Biddle, Joseph C. Fraley, C. Stuart Patterson, Mayer Sulzberger, the President, the Treasurer.

Programme.—William Pepper, Persifor Frazer, William A. Ingham, Joseph C. Fraley, I. Minis Hays.

The death was announced at Philadelphia, on January 29, 1898, of Dr. Theophilus Parvin, aged 69 years.

Prof. W. B. Scott read by title the following papers intended for the *Transactions:* "The Osteology of Eliotherium" and "Notes on the Canidæ of the White River Oligocene."

Prof. W. B. Scott presented a paper on "The Exploration of Patagonia."

Pending nominations Nos. 1432, 1435 and 1445 to 1450 were read.

The Society was adjourned by the presiding officer.

Stated Meeting, February 18, 1898.

Vice-President SELLERS in the Chair.

Present, 20 members.

The Special Committee on Prof. Scott's papers, entitled "Notes on the Canidæ of the White River Oligocene" and "The Osteology of Elotherium," recommended their publication in the *Transactions*, which was so ordered.

The Special Committee on Dr. Harrison Allen's papers presented for the *Transactions*, entitled "The Glossopha-

ginæ" and "The Skull and Teeth of the Ectophylla alba," recommended their publication, which was so ordered.

The death was announced of Rev. William C. Cattell, D.D., on February 11, in his seventy-first year.

The President, on motion, appointed Dr. McCook to prepare an obituary notice of Dr. Cattell.

Dr. Carl Lumholtz read a paper on "The Huichol Indians of Mexico and Their Objective Symbols," which was discussed by Dr. Brinton and Mr. Culin.

Pending nominations were read and spoken to, and the Society proceeded to the election of new members, after which the Tellers reported the following persons had been elected members:

2367. Thomas H. Montgomery, Jr., Philadelphia.
2368. W. L. R. Emmet, Schenectady, N. Y.
2369. George H. Darwin, F.R.S., Cambridge, Mass.
2370. S. Dana Greene, Schenectady, N. Y.
2371. L. B. Stillwell, Buffalo, N. Y.
2372. Charles F. Scott, Pittsburgh, Pa.

The Society was adjourned by the presiding officer.

Stated Meeting, March 4, 1898.

Vice-President SELLERS in the Chair.

Present, 9 members.

Mr. T. H. Montgomery, Jr., a newly elected member, was presented and took his seat in the Society.

Letters accepting membership were read from W. L. R. Emmet, Thomas H. Montgomery, Jr., and Percival Lowell.

The death, in his eighty-third year, of Rev. James Legge, D.D., LL.D., of Oxford, England, was announced.

Pending nominations 1432 and 1451 and new nominations 1452 and 1453 were read.

The Society was adjourned by the presiding officer.

Stated Meeting, March 18, 1898.

Dr. I. MINIS HAYS in the Chair.

Present, 11 members.

Acknowledgments of election to membership were read from Charles F. Scott, of Pittsburgh, Pa.; George H. Darwin, of Cambridge, Eng.; S. Dana Greene, of New York, and L. B. Stillwell, of Niagara Falls, N. Y.

Correspondence was submitted and donations to the Library and Cabinet were reported.

Announcement was made of the death of Sir Henry Bessemer, at his residence near London, on March 15, 1898, in the 85th year of his age; and of the Rev. Dr. Edward A. Foggo, at Philadelphia, March 8, 1898, aged 64.

The following communications were presented:

By R. H. Mathews, "Initiation Ceremonies of the Native Tribes of Australia."

By W. B. Scott, "A Preliminary Note on the Selenodont Artiodactyls of the Uinta Formation."

Pending nominations Nos. 1432 and 1451 to 1453 and new nominations Nos. 1454 to 1457 were read.

The Society was adjourned by the presiding member.

INITIATION CEREMONIES OF AUSTRALIAN TRIBES.

(Plate V.)

BY R. H. MATHEWS, L.S.

(*Read March 18, 1898.*)

The Koombanggary tribe, which was at one time both numerous and important, inhabits the country from the south side of the Clarence river along the sea-coast about as far as Nambucca, extending westerly almost to the main dividing range. On the south they are bounded by the Thangatty tribe, occupying the Macleay river. The Anaywan tribe, scattered over the table-land of New South Wales, bound the Thangatty and Koombanggary people on

thewest. As no description of the *Būrbŭng* of these tribes has yet been published, I have prepared the following brief account of that ceremony as practiced within the district indicated. Their social organization is after the Kamilaroi type, being divided into four sections,[1] with numerous totems consisting of animals, plants and other natural objects.

A *Būrbŭng* is held at any time that there are a sufficient number of boys old enough to be installed as tribesmen; and the headman of the tribe, whose turn it is to take the initiative in calling the people together for this purpose, is generally agreed upon at the conclusion of the previous inaugural gathering which took place. When the appointed time comes round, the tribe who are charged with this duty select a suitable camping ground within their own territory, and some of the initiated men commence preparing the ground. While they are employed at this work, the principal headman dispatches messengers to such of the surrounding tribes as he wishes to join in the ceremony. These men are selected from among his own friends and belong to his own totem. Each messenger has generally one or more other men with him to keep him company, and he is provided with the emblems usually carried on such occasions, namely, a bull-roarer, several articles of a man's dress and some native weapons. The conduct of these messengers on their arrival in the proximity of the camp of the people to whom the invitation has been sent is very similar to the procedure previously explained in my descriptions of the initiation ceremonies of other tribes.

The situation of the general encampment as regards water and food supplies, and the location of the visiting tribes around the local mob, are also substantially the same as already stated. In a retired spot, a short distance from the main camp, the headmen have a private meeting place, called the *bunbul*, where they congregate to discuss such matters as they do not wish the women to hear. They have one or more fires around which they sit, and none of the uninitiated men are allowed near them. The women must not intrude upon the *bunbul*, even if the men are not there. The single women and girls also have a place near the camp, but in the opposite direction, where they assemble to work at making nets, headbands and

[1] I have given the names of the divisions of these people in my paper on "The Totemic Divisions of Australian Tribes," *Journ. Roy. Soc. N. S. Wales*, xxxi, 168–170.

such like. Every aboriginal camp is kept free from excrementitious matter. When the people go out to attend to any necessity of nature, they at once make a hole in the ground and cover the deposit over with earth.

In close proximity to the camp is the *būrbūng* or public ring, bounded by a low earthen embankment, with a narrow sunken pathway called *maro*, leading about four or five hundred yards into the forest to another circular space, formed in the same manner, known as the *eeteemat*, in the floor of which the butts of two saplings are firmly inserted, having the rooty ends upwards. These inverted stumps are called *warringooringa*, and are prepared in the way described in my papers dealing with initiation ceremonies elsewhere.[1] The *maro* enters both the circles through a narrow opening left in the embankment, and the latter is continued outward a few feet along either side of the path where it meets the rings. Within the *eeteemat* there are also sometimes two, and sometimes four, heaps of earth, about a foot and a half or two feet high.

Around the outside of the *eeteemat* and along both sides of the pathway referred to, there are a number of trees marked with the usual *moombeera* devices, as well as the outlines of an iguana, a squirrel, the new moon and other figures, all chopped into the bark with a tomahawk. On one side of the path are some tracks of an emu's foot, cut into the surface of the ground a few feet apart, as if made by that animal running along. These tracks lead away some distance into the adjacent bush, forming a sort of curve or semicircle around the *eeteemat;* and on following them up they are found to terminate at the prone figure of an emu, *ngooroon*, formed by heaping up the loose earth into the required shape. All over the body of the emu thus drawn in high relief small twigs of the oak or wattle tree are closely inserted to represent the feathers of the bird.[2] All the sticks and loose rubbish are scraped off the surface of the ground for several yards around this figure, for the purpose of dancing on.

Approaching the *eeteemat*, near one side of the pathway, there is a low mound of earth about a foot high. This is called *kooroorballunga*, and a fire is lit on top of it during the time that any per-

[1] "The Bora of the Kamilaroi Tribes," *Journ. Anthrop. Inst.*, xxv, 325.

[2] The fronds or leaves of these trees bear some resemblance to the emu's feathers.

formance is going on, such as the arrival of a tribe, their daily games and the ceremonial connected with the removal of the novices.

In the vicinity of the marked trees is a gigantic human figure named *Dharroogan* or *Gowang*, lying extended on the ground, composed of the loose soil scraped off the surface for some yards around. A little way farther on, near the *eeteemat*, is the prostrate image of a wallaroo, formed in high relief in the same manner. In building all the earthen figures just described, stones or pieces of wood are first heaped up on the ground, almost to the height of the object required, and on top of this the loose earth is thrown to complete the figure and give it the necessary shape. The finished drawing represents the intended animal in high relief on the surface of the ground.

A rope made of stringy bark is stretched between two of the marked trees which are not too far apart, and about midway along this rope there is a bundle of leaves and finely frayed pieces of soft bark, supposed to represent the rest of a ring-tail opossum.[1]

When a strange tribe reaches a point somewhere within an easy stage of the main camp they paint their bodies with colored clays in accordance with the style customary in their tribe, after which the journey forward is resumed, the men in the lead, with the women and children following. On the approach of the strangers, the men of the local mob, and also the men of previous contingents who have arrived at the main camp, stand outside the *būrbŭng* circle with their spears and other weapons in their hands, and sway their bodies to and fro. The new arrivals then march on in single file, in a meandering line, each man carrying his weapons in his hands; they enter the ring and march round and round until they are all within it in a spiral fold. They now come to a stand and jump about, the headman calling out the names of camping grounds, water-holes, shady trees, etc., in their country. After this they come out of the ring and each detachment of the hosts enter it in succession and act in a similar manner. For example, the contingent from Kempsey, who had arrived first, entered the ring and called out the names of remarkable places; next, the contingent from Armidale did likewise; then the contingent from Tabulam, and so on. Lastly, the men of the local Nymboi river mob enter

[1] All the animals drawn upon the trees, or on the ground, represent the totems of some of the people assembled at the main camp.

the ring and act in the same way. While this reception is being accorded to the men, the women, novices and children go into the camping ground and take up their quarters on the side nearest their own country.

The men of the newly arrived contingent are next taken along the track to the sacred ground, and are shown all the markings in the soil and on the trees, the earthen figures in high relief, and the fire, at each of which they dance and give a shout. They then start along the tracks of the emu, some men being on one side and some on the other, the front men pretending to be following the marks in the ground. They make short grunt-like exclamations as they run along and all the other men follow in a body. On reaching the figure of the emu, they all give a shout and dance round on the clear space before referred to.

They next assemble around the *eeteemat* and are shown the *warrangooringa*, on the roots of each of which an old man is sitting performing magical feats. Some of the headmen enter the ring dancing and singing round the heaps of earth and the *warrangooringa*, after which the two men descend from the latter and join the others. All the wizards or "doctors" take their turn at producing rock-crystals, blood, string and other substances from different parts of their bodies. After each trick, these clever fellows run with their heads down amongst the men who are standing outside the ring, who jump around to get out of their way. At the conclusion of these performances all the men go back along the track, and at about, say fifty yards from the *bŭrbŭng*, they are met by the novices, who join the procession, taking their places with the men of their own sectional division,[1] who enter the ring and dance round a few times, naming remarkable localities in their several districts, their totems, etc., and the women, who are standing around outside, throw handfuls of leaves at them, after which they all disperse to their respective quarters.

A week or two, and in some cases a much longer time, elapses between the arrival of the first contingent and the last mob who have been invited from the surrounding districts, so that the earlier arrivals have a good while to wait at the main camp. During this period carraborus are held almost every fine night, the different tribes present taking their turn at providing the evening's amusement. The men go out hunting every day and the women proceed

[1] *Journ. Roy. Soc. N. S. Wales*, xxxi, 169.

in search of vegetable food, but there are always some of the old men and women in the camp. Each afternoon when the men return from the hunting or fishing expeditions, which have engaged them during the earlier portion of the day, the men of the local tribe start from the camp and walk away to the *eeteemat*, carrying a boomerang or some other weapon in each hand. They are shortly afterwards followed by the men of the other tribes, each mob starting in the order of their arrival at the main camp. On reaching the ring they look over the *moombeera*, the raised and carved figures on the ground, the *warrangooringa*, etc., and go through practically the same routine—and return to the *bŭrbŭng* in the same manner—as on the arrival of a new tribe. On some days during their visit to the *eeteemat*, the bullroarer is sounded, and the men beat the ground with pieces of bark held in the hand. It may be that a few additional trees are marked on these occasions, or some improvements are made in the earthen figures, or any other extra work which may add to the embellishment of the ground.

As soon as convenient after the arrival of all the tribes who are expected to join in the ceremony the headmen assemble, and after a consultation among themselves they determine the day on which the novices will be taken away for the purpose of initiation. The *Kooringal*, or band of men who are to take charge of the ceremonies in the bush, are selected and the locality fixed where the women are to erect the new camp and wait for the return of the novices. On the morning which has been decided upon for taking the boys away, the whole camp is astir at daylight. The painting of the novices is now proceeded with, all of them being adorned with red ochre and grease from head to foot. Each boy is then invested with a girdle, to which four "tails" or kilts are attached, one hanging down in front, one at each side and one behind. They are then conducted into the *bŭrbŭng* ring and placed sitting down on the raised earthen wall, the boys of each tribe being in a group by themselves on the side of the ring which is nearest their own country. The mother of each novice is then seated outside the embankment a few yards behind where he is sitting; his sisters and the other women are placed on the ground a little farther back. A screen of boughs is erected between each group of mothers and their sons. One or more of the headmen now go along the groups of novices and throw a rug over the head of each boy. All the women and children are told to lie down and keep still, and are covered

with rugs, bushes or grass, which have been placed in readiness for the purpose. The women then commence making a low humming or chanting noise, and several old men armed with spears keep watch over them to see that no attempt is made to remove the covering or look about.

When these preliminaries have been completed, two men sound bull-roarers (*yooloodurее* or *yeemboomul*) in close proximity and a few other men come along the path and run round inside the circle beating the ground with pieces of bark, similar to those described in my paper on *The Bŭrbŭng of the Wiradthuri Tribes*.[1] All the men who are standing about the circle shout and beat their weapons together, a separate detachment of men being located near each group of women for this purpose. During the combined noise of the bull-roarers, the shouting and the beating of the ground, the guardians advance, and, assisted by some of their friends, raise the novices on their shoulders and carry them away, their heads being still covered with the rugs to prevent their seeing anything. The novices are taken as far as the commencement of the *moombeera*, where they are placed lying on the ground with the rugs spread over them. Here they are kept a short time until the women depart from the *bŭrbŭng*, particulars of which will be given presently. This delay also furnishes an opportunity to the men who have been chosen for the *kooringal* to go on to the *kooroorballunga* and paint their bodies jet black with powdered charcoal and grease.

The novices are then raised to their feet and the rugs are adjusted on their heads in such a manner that they can only see the ground in front of them. Their guardians lead them along the pathway and they are shown the marked trees, the drawings on the ground, the fire, the squirrel's nest, etc., and are told to take particular notice of all these things. They are next conducted along the tracks of the emu until they reach the bird lying on the ground, as already described, around which some old men dance and all the people give a shout. After this they proceed to the *eeteemat*, and the novices are placed standing in a row. On being told to raise their eyes, they see two old men sitting on the *warrangooringa* exhibiting different substances out of their mouths, whilst some of the other men are dancing around the heaps of earth. An old man with a *coolamin* of human blood now approaches the novices and rubs some of the blood on their wrists. The guardians again bend

[1] *Journ. Anthrop. Inst.*, xxv, 308, Pl. xxvi, Fig. 40.

down the boys' heads and a start is made for the bush. The *warrangooringa* stumps are then pulled out of the ground and placed upon the fire, some of the men remaining in the vicinity until they are consumed.

I must now take the reader back to the *būrbūng* ring. Shortly after the guardians and novices get out of sight, the bushes and other coverings are taken off the women and children by the men who have remained in charge of them. They then gather up their baggage and remove to another locality, perhaps several miles distant, where they erect a new camp, each tribe selecting their quarters on the side of the camping ground nearest their own country. Before starting from the *būrbūng*, a pole is inserted in the ground in a slanting position, elevated and pointing in the direction of the place where the new camp is to be established. If this locality is some distance off, a long pole is used, making a considerable angle with the horizon, but if the camp is not far away, the pole is shorter and the angle of elevation less. The upper end is decorated by having a bunch of green boughs, grass or feathers attached to it. This indicator is left for the guidance of any natives who may arrive at the main camp after the assemblage has broken up.

As already stated, the novices have started with the men into the bush. They march along with the rugs projecting on each side of the face like a hood—their guardians being with them, and the other men following, making a considerable noise. During the afternoon they arrive at the place where it is intended they shall remain for the night. A semicircular yard is made of bushes or bark, and the novices are placed sitting on leaves spread upon the ground, their backs being toward the men's camp, which may be fifty or sixty yards away. This camp is called *karpan*. Between the men's quarters and the yard in which the novices are kept a space is cleared of all loose rubbish, and one or more fires lit to afford sufficient illumination. After the evening meal has been disposed of, the boys are brought out of their yard and are put sitting down facing the fires, while the Kooringal go through various pantomimic representations and traditional songs. These performances consist for the most part of imitating animals with which the people are familiar, or scenes from their daily life; and, like the ceremonials of other savage races, are largely mixed with obscene gestures. The animals selected include, amongst others, the totems of some of the novices, the headmen and the kooringal.

During the day the men go out hunting, to provide food for all the party, but the novices remain in the camp in charge of a few of their guardians. Several days may be spent in one camp, or perhaps a fresh camping place is reached every night, especially if game is scarce. In the latter case it would be necessary for the novices and guardians to accompany the rest of the men. The novices march along with the rugs on their heads, and when stoppages are made in the bush they are placed sitting on the ground with their hands clutching their genitals. On arriving at the place which has been agreed upon as the camping ground for the night, a yard is made for the boys in the usual manner. During the evenings at these camping places human ordure is occasionally given to the novices in addition to their daily food. If they want anything they are not allowed to ask for it, but must make a sign to the guardian who has charge of them. Some or all of the men who are not attached to the kooringal may go away for a day or two to another camping place some miles distant in quest of food, and contribute a fair share of game to the maintenance of the novices and guardians.

The period spent in the bush with the kooringal is about ten days or a fortnight, being regulated by the weather and other considerations. Different burlesques and songs take place every day, but the general character of the procedure is the same. If the wombat totem is represented, the kooringal crawl under a log as if going into a wombat's hole; if they select the scrub-turkey, all the men scratch the ground with their feet, kicking the rubbish backwards into a large heap resembling the nest of those birds; and so on for any other totems which may be represented.

When the course of instruction in the bush is nearly completed, some strange men, called *irghindaly* or *wyendee*, come from the *ahrowanga*, or women's camp. They belong to a distant part of the tribal territory, and this is their first participation in the ceremony. On approaching the *karpan*, they utter a weird noise, like the howling of the wild dog, and advance in single file, each man holding a leafy bough in front of him, which hides the upper part of his body. The novices are led to believe that a strange mob of blacks are coming to attack the camp. They are then raised to their feet, and placed standing in a row, with their guardians, some of the kooringal, standing on the right and some on the left of the row of boys, having the latter in the middle, holding their hands

to their ears. By this time the *irghindaly* have reached the camp, and form into a line parallel with and facing the row of men and novices. They jump and shake their boughs, and then, throwing the latter on the ground, they retire a few yards. The kooringal now step forward and pick up the boughs and strip the leaves off them, shouting *wah ! wah !* while doing so. The *irghindaly* then consult with the headmen, and arrange the time for the return of the novices to the *ahrowanga*, after which they go back to the camp from which they have come, and inform the women when the boys may be expected. The mission of the *irghindaly* is analogous to that of the *beegay* of the Kamilaroi, described by me elsewhere, namely, to liberate the novices from the rigorous custody of the kooringal.

That evening at the *karpan*, by the light of the camp fires, some of the usual totemic representations are enacted by the kooringal, after which some of the old men chant *Dharroogan's* song. About sunrise next morning the novices are placed standing in a row beside the camp, with their eyes cast upon the ground. All the men then run about pretending to throw pieces of stick at a squirrel in a tree, and while they are doing so two men step into an open space and swing the *yooloodury*. The blankets are then lifted off the heads of the novices, who are requested to take particular notice of this ceremony. Some armed warriors now rush up to each of the novices in a menacing attitude, and caution them against revealing what they have been taught during their sojourn in the bush. At the conclusion of these proceedings, everything is packed up and a start made toward the women's camp.

After proceeding some miles the party come to a halt at a water-hole or running stream. Here a fire is lit, and they partake of such game as may have been caught during the morning. By and by all the kooringal gather on the bank of the water-hole or creek, and one after another goes into the water, washing off the black coloring matter, after which they come out, and paint their bodies all over with pipe clay. During this time the novices are sitting on the bank of the water-hole—or near the fire if the day is cold—and do not participate in the washing and painting ceremony. This water-hole is one which is always used for the same purpose at every *būrbŭng* which takes place in this part of the tribal territory, and is never used for bathing on any other occasion. The journey forward is then resumed, and one of the men goes on ahead to report that the bush contingent will shortly arrive.

I must now give some further particulars of the new camp erected by the women, referred to in an earlier page. The same camp may be occupied all the time the novices are away, or the women may shift to a fresh camping ground every few nights, in conformity with the movements of the kooringal. A patch of ground is cleared near each of these camping places, to which the mothers and sisters of the novices repair every evening for the purpose of singing and dancing during the time the boys are away in the bush with the headmen. As soon as the women are informed of the day which has been fixed for the return of the kooringal, they proceed to this cleared space and erect an avenue of boughs, called the *arrowanga*, in the following manner. In this work they are assisted by the old men who have been with them all the time, and also by the *irghindaly* contingent. A number of small green saplings are cut down with tomahawks, and the stems are inserted in holes made in the ground, all in a line—the bushy tops being sufficiently close together to make a leafy screen, about four feet high. A few feet from this, another line of saplings is set up, parallel with the other. The two rows of boughs are fixed in the ground with a slant toward each other, so that their tops almost meet overhead, forming a kind of arched avenue long enough to hold all the kooringal. A few yards on one side of this avenue, and parallel thereto, the women light about four fires, beyond which they sit down in a row, and commence chanting in monotonous tones.

When all is ready, a signal is given by the men who have charge of the women, and the bush mob approach in single file, all painted white, as already stated. On coming in sight of the *arrowanga*, the novices and their guardians stop behind, and go to another camp a little way off, where they remain for the night. The women are now told to lie down, and are covered with bushes. The kooringal march on and enter the avenue of bushes, one after the other, and sit down with their legs gathered under them in the usual native fashion. During this time a small bull-roarer, called *dhalgüngun*, is sounded out of sight in the rear. A few of the headmen jump round outside the avenue, beating together two boomerangs, and muttering *wooh ! wooh !* After going round two or three times, they shout *birr ! birr !* and all the women stand up and dance round the men who are hidden in the avenue. After going round a few times, the women commence pulling down the bough screen, upon which all the kooringal rise to their feet, and also

commence pulling the bushes out of the ground, breaking them smaller and throwing them on the fires as they jump about. The women also assist in breaking the twigs off the boughs and placing them on the fires. By this time a dense smoke is issuing from the burning bushes, and some of the kooringal stand in the smoke around each fire until they are all sufficiently fumigated. A few of the old headmen stand round directing the proceedings, and the *irghindaly* assist in throwing bushes on the fires when more smoke is required. While the kooringal are standing on the smouldering boughs, the women come up and rub their hands on them, ostensibly to wipe the white paint off them. When the ceremony is over it is getting near sundown, and the kooringal mix with the women and *irghindaly*, and all of them go into the camp adjacent.

During the forenoon of the following day the mothers and sisters of the novices, accompanied by some of the men, again muster at the *arrowanga*, but on this occasion no bough screen is erected, and the women are allowed to see everything which takes place. Some fires are lit and green bushes cut and laid round ready for use. At the camp to which the novices and their guardians went the evening before preparations are also made for the approaching ceremony. The bodies of the boys are smeared over with ashes from the camp fires, and the hair of their heads is singed, to make the women believe that they have been burnt by the evil spirit and have just emerged from the fire. After a mutual interchange of signals that everything is ready at both camps the guardians and novices start forward, marching two and two till they arrive at the *arrowanga*. As they approach the women shout "Heh! heh!" and throw pieces of bark over their heads. The *irghindaly* lay some of the green bushes on the fires and each guardian conducts his novice into the smoke, which curls upward around them both. The mothers of the boys, who have been standing on one side, now advance and rub their open hands over the bodies of their sons, after which they rub their teats on their mouths. The sisters of the novices next step forward and rub their feet on their brothers' ankles. During the whole of this ceremony the novices keep their eyes cast down, and do not look at their mothers or sisters. A signal is now given and they scamper off with their guardians to a camp which has been prepared for them not far away.

At the conclusion of the ceremonies at the *arrowanga* all the tribes shift camp to another place, perhaps a few miles away, and

next morning the novices are brought up in close proximity, where they are again smoked, after which they are invited to partake of food spread upon nets by the women. They are then conducted to a camp a little way from the men's quarters, where the old headmen show them quartz crystals and other sacred substances; and also small pieces of wood called *bandhanyay* or *kungara*, on which certain mystic lines are made, said to be the work of Dharroogan. They are forbidden to eat certain kinds of food until released from these restrictions by the old men.

The ceremonies being now at an end, the visiting tribes make preparations for starting on their return journey, and in a few days most of them are on their way homeward, each tribe taking their own novices with them. The latter are kept under the control of their seniors for a considerable time, and must conform to certain rules laid down by the headmen. It is also necessary that they shall attend one or more additional *Būrbŭng* gatherings before they can become thoroughly acquainted with the different parts of the ceremonial and be fully qualified to take their place as men of the tribe.

On the Macleay river there is an abbreviated form of inaugural rite, known as the *Murrawin*, and among the tribes occupying the Nymboi and Mitchell rivers there is a short ceremony called the *Walloonggurra*. Both these rites are of a probationary character, leading up to the fuller ceremonial of the *būrbŭng*, from which they differ in so many respects that I have thought it necessary to describe them in separate articles.

Before cannibalism ceased to be practiced by the tribes dealt with in this paper it was the custom to kill and eat a man during the *būrbŭng* ceremonies. The victim was an initiated man of the tribe, and his flesh and blood were consumed by the men and novices. I am preparing an article dealing fully with this and similar customs, so that further reference is unnecessary at present.

Explanation of Plate V.

The *būrbŭng* described in the preceding pages completes a series of articles written by me on the different types of initiatory rites of the aboriginal tribes scattered over the whole of New South Wales. I have now prepared a map of the colony, defining the boundaries of the several districts within which each type of ceremony

is in force. On this map I have marked the approximate position of these boundaries, and have assigned to each district a distinguishing numeral, from 1 to 9, so that they can be readily identified. It is outside the purpose of this paper to define the areas occupied by the people speaking the different dialects prevalent in each district, but the names of some of the most important of them will be stated in a general way under each number. The reader will be referred to certain articles which I have published describing the initiation ceremonies, and also the totemic divisions of the tribes located inside the boundaries shown upon the map.

No. 1 on the map represents a wide zone of country stretching from near the Murray river almost to the Barwon, occupied chiefly by the Wiradjuri-speaking people. This includes the Wonghibons, a branch of the Wiradjuri, who are spread over the country from Mossgiel to Nyngan.[1] On the Lower Murrumbidgee and extending up the Murray from about Euston are several small tribes speaking the following dialects: The Eetha-eetha, Watthi-watthi, Kianigani, Yuppila, Yota Yota, Boorabirraba and some others on the upper Murray whose initiation ceremonies are the same as the Wiradjuri. For my descriptions of the *būrbŭng* of these people the reader is invited to peruse the following publications: *Journ. Anthrop. Inst. London*, Vol. xxv, pp. 295–318; *Ibid.*, Vol. xxvi, pp. 272–275. *Proc. Roy. Geog. Soc. Aust.* (Q.), Vol. xi, pp. 167–169, and *Journ. Roy. Soc. N. S. Wales*, Vol. xxxi, pp. 111–153. I have also dealt with their totemic division in the last-named work, pp. 171–176.

No. 2 includes the country of the Kamilaroi, Yookumble, Wallaroi, Pickumble, Yuollary, Wailwan, Moorawarree and a few others. The Bora ceremony of these tribes is described by me in the following works: *Journ. Anthrop. Inst. London*, Vol. xxiv, pp. 411–427; *Ibid.*, Vol. xxv, pp. 318–339; *Journ. Roy. Soc. N. S. Wales*, Vol. xxviii, pp. 98–129; *Ibid.*, Vol. xxx, pp. 211–213; *Proc. Roy. Soc. Victoria*, Vol. ix, N. S., pp. 137–173. I have described their totemic divisions in *Journ. Roy. Soc. N. S. Wales*, Vol. xxxi, pp. 156–168.

No. 3. In this tract of country the Bunan ceremony is in force. Some of the dialects are the Thurrawall, Wodi Wodi, Jeringin, Ngarroogoo, Beddiwell, Mudthang, Dhooroomba, Gundungurra

[1] Mr. A. L. P. Cameron kindly furnished me with the location of the Wonghibon, Eethee Eethee and Watthi Watthi tribes.

and Wonnawal. I have given a comprehensive account of this ceremony, with a plate illustrating the Bunan ground and the different objects connected with it in the *American Anthropologist*, Washington, Vol. ix, pp. 327–344.

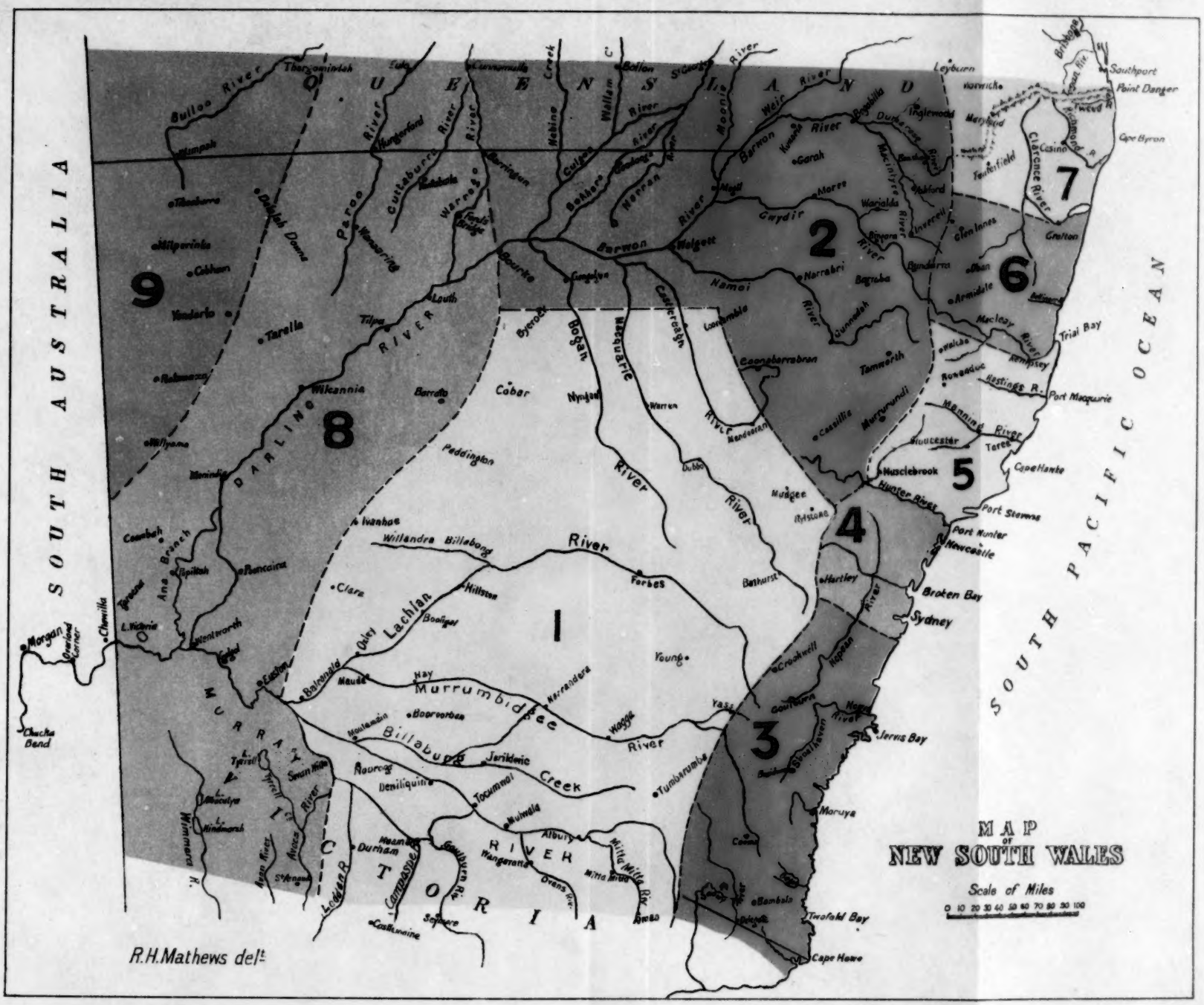
No. 4 represents the country occupied by the tribes speaking the Darkinung, Wannerawa, Warrimee, Wannungine, Dharrook and some other dialects. Their country commences at the Hunter river and extends southerly till it meets and merges into that of the people of No. 3. Their ceremony of initiation is known as the Narramang, which is described in a paper published in *Proc. Roy. Soc. Victoria*, Vol. x, N. S., pp. 1–12. Their totemic system is dealt with in *Journ. Roy. Soc. N. S. Wales*, Vol. xxxi, pp. 170–171.

No. 5. Within this area, which extends from the Hunter river almost to the Macleay, the initiation ceremonies are of the Keeparra type described by me in *Journ. Anthrop. Inst. London*, Vol. xxvi, pp. 320–340. This tract of country is inhabited by the remnants of the tribes speaking different dialects, some of the most important of which are the following: Wattung, Gooreenggai, Minyowa, Molo, Kutthack, Bahree, Karrapath, Birrapee, etc. North of the Hunter river and extending along the sea coast to about Cape Hawk there is an elementary ceremony called Dhalgai, which I have included in the article last quoted.

No. 6 represents the hunting grounds of the tribes whose initiation ceremonies are dealt with in the preceding pages. Their sectional divisions are the same as the tribes in No. 5, and are described in *Jour. Roy. Soc. N. S. Wales*, Vol. xxxi, pp. 168–170.

No. 7 comprises the country of the Bunjellung, Gidjoobal, Kahwul, Nowgyjul, Watchee, Yackarabul, Ngandowul and some other small tribes, whose initiation ceremonies are of the Wandarral type, described by me in *Proc. Roy. Soc. Victoria*, Vol. x, N. S., pp. 29–42. Districts Nos. 2, 7, 8 and 9 cross the boundary of Queensland, and Nos. 1 and 8 extend some distance into the Victorian frontier.

No. 8. On the west of Nos. 1 and 2 are the Barkunji, Bungyarlee, Bahroongee, Wombungee, Noolulgo and some other tribes, occupying the country on both sides of the Darling river, as well as on the Lower Paroo and Warrego. South of the Murray river are several small tribes, among which may be mentioned the Wamba Wamba, Waiky Waiky, Latjoo Latjoo, Mutti Mutti, etc. I have


SOUTH AUSTRALIA
QUEENSLAND
NEW SOUTH WALES
VICTORIA
SOUTH PACIFIC OCEAN
1
2
3
4
5
6
7
8
9
MAP
OF
NEW SOUTH WALES
Scale of Miles
0 10 20 30 40 50 60 70 80 90 100
R.H.Mathews del.
Darling River
Murrumbidgee River
Lachlan River
Murray River
Billabung
Jeridderie Creek
Tumbarumba
Albury
Wangaratta
Mitta Mitta River
Omeo
Cape Howe
Twofold Bay
Bombala
Jervis Bay
Sydney
Broken Bay
Port Stephens
Port Hunter
Newcastle
Port Macquarie
Trial Bay
Grafton
Tweed R.
Southport
Point Danger
Cape Byron
Brisbane
Ipswich
Warwick
Leyburn
Inglewood
Casino
Tenterfield
Clarence River
Macleay River
Armidale
Tamworth
Gunnedah
Narrabri
Walgett
Moree
Gwydir
Namoi
Barwon
Castlereagh
Bogan
Macquarie
Cudgegong River
Culgoa
Bokhara
Warrego
Paroo
Cuttaburra
Hungerford
Bulloo River
Thargomindah
Eulo
Cunnamulla
Wallam Creek
Hebina
Bollon
Moonie River
Weir River
Boggabilla
Dumaresq River
Macintyre River
Severn River
Dalgety
Cooma
Bega
Moruya
Batemans Bay
Nowra
Kiama
Wollongong
Goulburn
Crookwell
Yass
Gundagai
Tumut
Adelong
Tumbarumba
Jindabyne
Kosciusko
Mt. Buffalo
Bright
Beechworth
Wodonga
Albury
Corowa
Deniliquin
Tocumwal
Mulwala
Swan Hill
Tyrrell L.
Lake Boga
Mildura
Wentworth
Balranald
Hay
Maude
Narrandera
Hillston
Booligal
Oxley
Forbes
Parkes
Molong
Orange
Bathurst
Lithgow
Mudgee
Rylstone
Muswellbrook
Singleton
Maitland
Cessnock
Gosford
Wyong
Hornsby
Parramatta
Liverpool
Campbelltown
Picton
Bowral
Moss Vale
Berrima
Goulburn
Young
Cowra
Canowindra
Molong
Dubbo
Peak Hill
Parkes
Forbes
Condobolin
Nyngan
Warren
Coonamble
Gilgandra
Coonabarabran
Walgett
Collarenebri
Mungindi
Goondiwindi
Texas
Stanthorpe
Warwick
Toowoomba
Dalby
Chinchilla
Miles
Roma
Mitchell
Surat
Tambo
Augathella
Charleville
Cunnamulla
Eulo
Thargomindah
Hungerford
Quilpie
Windorah
Birdsville
Innamincka
Cooper Creek
Lake Eyre
Lake Frome
Broken Hill
Wilcannia
Menindee
Ivanhoe
Hillston
Griffith
Leeton
Narrandera
Wagga
Junee
Cootamundra
Gundagai
Tumut
Batlow
Adelong
Tumbarumba
Jindabyne
Kosciusko
Mt. Buffalo
Bright
Beechworth
Wodonga
Albury
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Junee
Cootamundra
Gundagai
Tumut
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Tumbarumba
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Hungerford
Quilpie
Windorah
Birdsville
Innamincka
Cooper Creek
Lake Eyre
Lake Frome
Broken Hill
Wilcannia
Menindee
Ivanhoe
Hillston
Griffith
Leeton
Narrandera
Wagga
Junee
Cootamundra
Gundagai
Tumut
Batlow
Adelong
Tumbarumba
Jindabyne
Kosciusko
Mt. Buffalo
Bright
Beechworth
Wodonga
Albury
Corowa
Deniliquin
Tocumwal
Mulwala
Swan Hill
Tyrrell L.
Lake Boga
Mildura
Wentworth
Balranald
Hay
Maude
Narrandera
Hillston
Booligal
Oxley
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Parkes
Molong
Orange
Bathurst
Lithgow
Mudgee
Rylstone
Muswellbrook
Singleton
Maitland
Cessnock
Gosford
Wyong
Hornsby
Parramatta
Liverpool
Campbelltown
Picton
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Moss Vale
Berrima
Goulburn
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Canowindra
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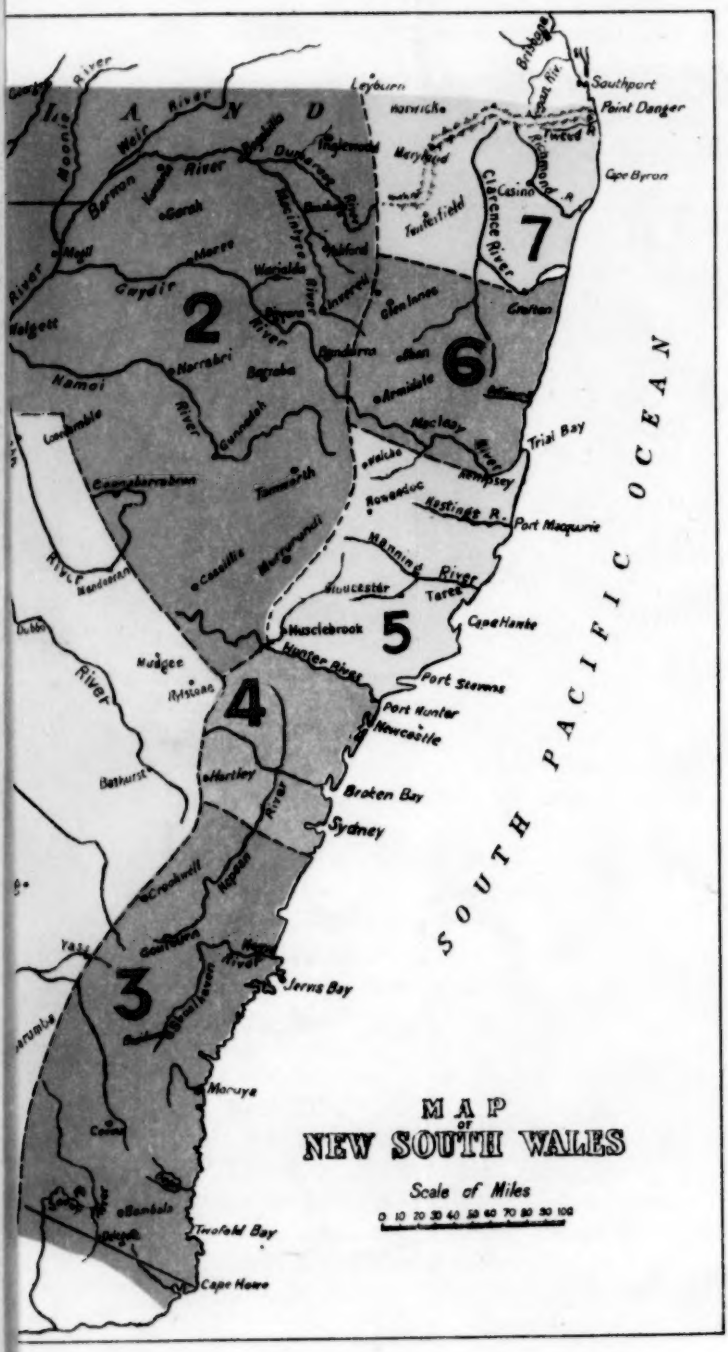
Coonabarabran
Walgett
Collarenebri
Mungindi
Goondiwindi
Texas
Stanthorpe
Warwick
Toowoomba
Dalby
Chinchilla
Miles
Roma
Mitchell
Surat
Tambo
Augathella
Charleville
Cunnamulla
Eulo
Thargomindah
Hungerford
Quilpie
Windorah
Birdsville
Innamincka
Cooper Creek
Lake Eyre
Lake Frome
Broken Hill
Wilcannia
Menindee


MAP
OF
NEW SOUTH WALES
Scale of Miles
0 10 20 30 40 50 60 70 80 90 100
SOUTH PACIFIC OCEAN
1
2
3
4
5
6
7
Leyburn
Warwick
Southport
Point Danger
Cape Byron
Clarence River
Grafton
Casino
Tenterfield
Glen Innes
Armidale
Inverell
Warialda
Moree
Gwydir
Namoi
Narrabri
Gunnedah
Tamworth
Walgett
Coonamble
Coonabarabran
Castlereagh
Macquarie
Dubbo
Mudgee
Bathurst
Orange
Molong
Forbes
Parkes
Condobolin
Lachlan
Wellington
Nyngan
Bourke
Barwon
Darling
Culgoa
Balonne
Maranoa
Warrego
Wilcannia
Broken Hill
Tibooburra
Wentworth
Darling River
Murray River
Murrumbidgee
Lachlan
Macleay River
Trial Bay
Kempsey
Nambucca
Bellinger R.
Port Macquarie
Manning River
Taree
Gloucester
Cape Hawke
Muswellbrook
Hunter River
Port Stephens
Port Hunter
Newcastle
Broken Bay
Sydney
Goulburn
Crookwell
Yass
Gundagai
Tumut
Jervis Bay
Braidwood
Araluba
Moruya
Cooma
Bombala
Twofold Bay
Cape Howe

referred to the totemic divisions of the Barkunji and kindred tribes in *Proc. Roy. Geog. Soc. Aust.*, Queensland, Vol. x, p. 32. Their initiation ceremonies are described by me elsewhere.

No. 9. In this triangular portion of New South Wales we encounter the advance guard of those tribes who practice circumcision and subincision, extending thence northerly into Queensland and westerly into South Australia. The customs of these people will be dealt with by me in another article.

APPENDIX.

The Nguttan Initiation Ceremony.

In this article it is intended to give a short account of the *Nguttan*, an abbreviated ceremony of initiation practiced by the native tribes of the Williams and Gloucester rivers and surrounding country. Although it is not necessary to muster the whole community for the purpose of installing the youths into the privileges of tribesmen by means of the *Nguttan*, yet it is always thought safest to consult with the headmen of some of the nearest neighboring tribes, who may also have one or more youths old enough to pass through the ordeal. The preliminaries are arranged by means of messengers, and when the appointed time comes round the tribes proceed to the appointed meeting place. Here the combined concourse indulge in corrobories and songs at night by the camp fires. The men of each tribe dance in their turn and their women beat time for them.

When the festivities have lasted for a few days the headmen decide upon the time for taking away the novices. Early on the appointed morning all the men assemble under pretense of going on a hunting expedition, or perhaps they represent that they are making an incursion into the country of a hostile tribe for the purpose of avenging some supposed injury. The novices are mustered out of their mothers' camps and are taken charge of by the men. The women are not told anything about these proceedings, but all the elder ones and those who have been present at similar gatherings before form their own conclusions in regard to the purpose of the meeting.

A number of the men, with the novices amongst them, start first, and are immediately followed by the rest of the men, singing and shouting as they march along in the rear. The novices are told that

these incantations are for the purpose of making a plentiful supply of game, or to cause them to be victorious over their enemies. The men are painted in the manner customary on these expeditions. After traveling perhaps several miles they come to a water-hole or running stream, where a halt is made. The novices are now taken charge of by the men who have been appointed for this duty. Each of these men is the brother-in-law—actually or collaterally—of the graduate who has been placed under his care.

The novices are stripped naked, and after being painted are placed sitting cross-legged on the ground, with both hands grasping their genitalia and their heads bowed toward their breasts. Their guardians and some of their relatives remain with them, but all the other men go away, taking their departure quietly and a few at a time so that the boys may not know that they are gone. These men go away to a suitable camping ground, perhaps a mile or two distant, which has previously been agreed upon, and there they erect a camp of bark or bushes and spread leaves on the ground for the novices to lie upon. They then go into the bush hunting to provide food for themselves and the rest of the party. Late in the afternoon the guardians and other men who remained with the novices bring the latter to this new camp—each boy with his eyes cast down and being forbidden to look at anything around him—and place them lying down upon the leaves with rugs thrown over them. Fires are lit near where they are lying,[1] and they are subjected to considerable heat, which causes them to perspire very freely, but they are not permitted to move and must keep silent.

During the evening, perhaps an hour after sundown, by the light of the camp-fires, some of the usual totemic dances, described by me in previous communications, and other instructive performances, are gone through by the men, and the novices are allowed to sit up and look at them. Some of the men exhibit their genitals to the boys and invite them to pay especial attention to a number of other obscene gestures. After this human excrement is thrown to the novices, which they are required to eat, and also to drink urine out of a native vessel. At the conclusion of these proceedings all hands lie down for the night.

Early next morning about half the men start away without the knowledge of the boys and go into the bush in quest of food.

[1] Compare with the fire ordeal described by me in "The Bunan Ceremony of N. S. Wales," in the *American Anthropologist* (1896), Vol. ix, pp. 335, 336.

About midday they return, and on coming within hearing of the camp they commence making a weird noise, like the howling of the native dog, and advance in single file, each man carrying a leafy bough which hides his face and chest. When these men, who are called *ghirrang*, reach the camp where the novices are they spread out in a line and spring up into the air, waving their arms and uttering grunt-like exclamations. The novices are led to believe that the ghirrang belong to a hostile tribe and will perhaps attack them and their guardians.

The ghirrang and other men then produce several small sheets of bark stripped from trees, on which some *dharroong* devices have been carved, similar to the marks on the trees standing around a Keeparra ground.[1] These pieces of bark are placed at intervals of a few yards along the cleared space which was used for dancing and performing upon the previous night. The novices are now brought out in front of these pieces of bark and are invited to take particular notice of them. They are at first shown the dharroong on one sheet of bark, and are then taken to each of the others in succession, but are not allowed to speak a word.

When this part of the ceremony has been disposed of, the men form into two divisions—one mob standing on one side of the cleared space and another mob on the other side—the graduates being placed in a row facing them. The humming sound of the bull-roarer, *mudthinga*, is now heard a little way in the rear, and almost immediately two men step out into the opening, each man swinging one of these instruments at the end of a string. The usual obligations of secrecy are then imposed upon the neophytes, after which the sacred *mudthinga* is rubbed upon their penises, chests, arms and other parts of their bodies. While doing this the string of the bull-roarer is placed round each lad's neck in rotation.

The guardians, novices, and all the rest of the men now start away from that place, and proceed toward the women's camp—which, it should be mentioned, was removed to another locality the same day the men and boys went away. A man is sent ahead to announce that the contingent from the bush will return presently, and upon receipt of this message the women muster on a level, open parcel of land contiguous to their camp. Here the mothers of the neophytes spread nets upon the ground, on which

[1] See my "Keeparra Ceremony of Initiation," *Journ. Anthrop. Inst.*, Vol. xxvi, pp. 320–338, Pl. xxxii, Figs. 6 to 13.

they lay food for the use of their sons. The sisters of the novices and the other women also assemble near this spot, which is called *ngurra nyalla.*

When these preliminaries have been arranged, the men and boys come marching on, painted and dressed in their full regalia as men of the tribe, and as they approach the women throw sticks over their heads. The novices step forward to the nets, and eat the food which their mothers have provided for them. After this the women return to their own camp, but the graduates are taken by their guardians to a place near the single men's quarters. During that evening some of the old headmen show the novices the sacred white stones, which are so much valued by all native tribes.

These white stones, which in this district are called *buggan*, are said to be found in the scrubby mountains beyond Bandon Grove, near the head of the Williams river, and are supposed to be the excrement of *Gæñ Mudyer Dhingga* (Gœñ of the Hairy Hands), a malevolent being who has his abode in these mountain fastnesses. A number of clever old men—the so-called wizards of their tribes—used to make periodical expeditions into these regions for the purpose of obtaining supplies of the *buggan.* On these occasions it was not considered safe for a man to travel alone, but it was necessary that several should go in company. At their camps at night they were required to sing songs similar to those which form part of the *keeparra* ceremonial, and the camp-fires had to be maintained by burning certain kinds of wood to be found in that district. During the night, while the old men were asleep, Gœñ was supposed to appear, accompanied by some of his coadjutors, and put white stones into their *dilly* bags.

If any of the old men of the company had been remiss in their observance of any of the tribal customs, they would keep awake, holding a burning brand in their hand, in order to protect themselves against Gœñ's evil designs. The only way in which such men could secure the sacred *buggan* was to search for them along the sides of hills or watercourses, where they had been deposited by Gœñ.

Every youth who graduates through the Nguttan is required to attend the next keeparra ceremony which takes place among his own people—or the *būrbŭng* of those tribes who adjoin them on the northwest—in order that he may receive further instruction in the sacred initiatory rites of the community.

Short or probationary forms of inauguration ceremonies are found in several districts, and a knowledge of them is highly valuable, as exhibiting the various stages through which a youth must pass before he is qualified to take his place as a full man of his tribe. In a different portion of the same tract of country, there is another elementary ceremony known as the *Dhalgai*, described by me elsewhere.[1] Both the *Nguttan* and the *Dhalgai* are practiced in parts of the geographical area represented as No. 5 on the map of New South Wales hereto appended (Plate V).

PRELIMINARY NOTE ON THE SELENODONT ARTIODACTYLS OF THE UINTA FORMATION.

BY W. B. SCOTT.

(*Read March 18, 1898.*)

In 1895, Mr. J. B. Hatcher collected for the Princeton Museum some unusually well-preserved specimens of Selenodont Artiodactyls in the Uinta beds of northern Utah. In preparing a monograph upon these forms I have found certain new and undescribed genera which have proved to be of remarkable phylogenetic interest, and the much more complete material now available of genera previously named gives us most welcome information. As the detailed account of these fossils cannot appear for many months, it is desirable to publish a brief notice of the new forms and of the principal conclusions to which the study of the Uinta Selenodonts has led. One of the most marked changes between the mammalian life of the Bridger and that of the Uinta is in the great increase of the Artiodactyls in general and of the Selenodonts in particular. In the Bridger beds only two genera at most of the latter group have been described, and remains of even these are very rare; in the Uinta, on the other hand, Artiodactyls are the most abundant fossils and not less than eight genera of Selenodonts may be determined, while others are indicated by specimens not sufficiently well preserved for description.

The most interesting and striking result to which the study of the

[1] "The Dhalgai Ceremony," *Journ. Anthrop. Inst.*, Vol. xxvi, pp. 338–340.

Uinta Selenodonts has led is the very unexpected conclusion that, *with the possible exception of the Oreodonts and Agriochœrids, all of the strictly indigenous North American Selenodonts are derivatives of the Tylopodan stem.* The true Ruminants (Pecora) are an Old World type and did not reach this continent till late Miocene times, but the Tylopoda underwent an expansion and differentiation in America comparable to that of the Pecora in Europe, of which they took the place here. This conclusion was long ago suggested, with wonderful insight, by Rütimeyer, but as he did not discuss the question and brought forward no evidence in support of his views, the suggestion never attracted the attention which it so well deserved. The White River forms, *Leptomeryx*, *Hypertragulus*, *Hypisodus* and *Protoceras*, have long baffled the investigator who attempted to determine their true systematic position, but it has now become exceedingly probable that they are all variants of the Tylopodan type, the main line of which is represented in White River times by the genus *Poebrotherium*, whose position has long been recognized as ancestral to the modern camels and llamas. It should be added, however, that this somewhat surprising result has been much strengthened and confirmed by far more complete material of *Leptomeryx* and *Hypertraguus* than had previously been known. This new material, which was gathered at various times by Messrs. Hatcher and Gidley, makes the Tylopodan affinities of these White River genera much more conspicuous than any one had imagined. In the extended paper which is now in course of preparation these newly obtained specimens will be described and figured in comparison with their forerunners of the Uinta.

Parameryx Marsh.

Amer. Jour. Sci., third series, Vol. xiv, p. 364 (*nomen nudum*).
Ibid., Vol. xlviii, p. 269.

In this genus the dentition is complete, I. $\frac{3}{3}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{3}{3}$ and there are no diastemata. The incisors and canines are small, the premolars simple and trenchant and the molars very brachyodont and composed of four crescents. The skull is exceedingly like that of *Poebrotherium*, but has a shorter muzzle, a less capacious cranium, a more widely open orbit and a very much smaller tympanic bulla, which is not filled with cancellous tissue. The ulna and radius are separate, at least in young individuals; the manus consists of four

functional digits, though the lateral metacarpals are already very much more slender than the median pair. The fibula is complete and not coössified with the tibia at any point, but its shaft is so reduced as to be a mere thread of bone. The pes contains two functional metatarsals, iii and iv, while Nos. ii and v are long, filiform and splint-like rudiments to which, apparently, no phalanges are attached, but this is still doubtful. The phalanges of the functional digits resemble those of *Poebrotherium*, and the unguals have the same long, pointed and slender, antelope-like shape.

There can be very little doubt that *Parameryx* is the direct and immediate ancestor of the White River *Poebrotherium*, which it so much resembles, and thus it holds an important place in the main line of Tylopodan descent.

Leptotragulus Scott and Osborn.

Proc. Amer. Phil. Soc., 1887, p. 258.

In a former account of this genus,[1] the type of which is a fragment of the mandible containing p $\frac{3}{3}$, $\frac{4}{4}$ and m $\frac{1}{1}$, I made the mistake of referring to it certain limb and foot bones which, it is now apparent, belong to the very distinct genus *Parameryx*, from which *Leptotragulus* differs in the form of the premolars and in the presence of diastemata. At present I am not able to refer to the latter genus any of the newly acquired material, and hence can add nothing to my original account[2] of it. It differs but comparatively little, however, from the following genus, the structure of which may be very fully described.

Merycodesmus, gen. nov.

Dentition unreduced; I. $\frac{3}{3}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{3}{3}$; upper incisors conical, pointed and slightly recurved; upper canine large, compressed and thick; lower canine incisiform; p $\frac{1}{1}$ near canine, with diastema behind it; p $\frac{2}{2}$ with deuterocone; p $\frac{3}{3}$ caniniform and opposing upper canine; p $\frac{4}{4}$ with large deuteroconid. Molars composed of four crescentic lobes, m $\frac{3}{3}$ with fifth lobe. Forehead elongate and lozenge-shaped, sagittal crest short, as in *Parameryx;* mandible with very extended angle. Manus and pes having four

[1] Trans. Amer. Phil. Soc., Vol. XVI, p. 479.
[2] Proc. Amer. Phil. Soc., 1887, p. 258.

functional digits; lateral metapodials less reduced than in *Parameryx*.

Merycodesmus gracilis, sp. nov.

Size small; orbit small and bounded behind by very long decurved postorbital process of frontal; cranium relatively broad and capacious; mandible very slender.

Measurements.

Upper dentition, length I 1 to M 3	0.071
" premolar-molar series, length	.054
" molar series, length	.022
" canine, ant.-post, diameter	.006
" canine, transverse diameter	.003
" M 1, length	.006
" M 1, width	.0085
" M 2, length	.008
" M 2, width	.010
" M 3, length	.009
" M 3, width	.011
Lower dentition, length I 1 to M 3	.072
" premolar-molar series, length	.058
" premolar series, length	.032
" molar series, length	.026
" P 1, length	.0045
" P 2, length	.0055
" P 3, length	.007
" P 4, length	.0065
" M 1, length	.0065
" M 2, length	.0075
" M 3, length	.011

(N. B.—The apparently great length of the premolar series is due to the diastema behind p1)

The dentition of *Merycodesmus* is quite similar to that of *Parameryx*, but differs in certain very significant ways. Thus, the lower incisors have more chisel-shaped crowns, and the lower canine has become one of them in form and function; the upper canine is much larger and the first lower premolar has taken on the form and function of the canine. In each jaw a long diastema separates p 1

from p 2. The other premolars and the molars are much alike in the two genera save that the latter are relatively broader in *Merycodesmus*. This genus differ from *Leptotragulus* in the greater complexity of the inferior premolars, and especially in the large development of the deuteroconid on $p\frac{4}{}$. From *Oromeryx* it may be distinguished by the diastemata and by the more symmetrically quadrate shape of the upper molars.

The skull bears a close resemblance to that of *Parameryx*, but has a somewhat more elongate muzzle and longer postorbital processes of the frontals; the forehead has the same elongate lozenge-like shape, the temporal ridges converging gradually behind into the short sagittal crest; the mandible has an elongate, slender horizontal ramus, which is somewhat stouter than that of *Parameryx;* whether the very broad ascending ramus possessed a similar hook-like angle to that of the latter genus cannot at present be precisely determined; the coronoid process is even more recurved and pointed. The posterior nares are far back, their front border being opposite $m\frac{3}{}$, and a deep palatal notch intervenes between the hinder half of m^3 and the external wall of the narial canal.

The axis has a conical odontoid process.

The fore foot has four digits, of which the lateral metacarpals are reduced and slender, though distinctly less so than in *Parameryx*. The tarsus is lower than in the latter genus, and the lateral metatarsals are functional, not mere filiform splints. The phalanges are essentially alike in the two genera.

The entire structure of *Merycodesmus* strongly suggests that it was the forerunner of the White River genus, *Leptomeryx*, and, through a somewhat different line, of *Protoceras* also. In *Leptomeryx* the upper canines have been lost, the lower canine resembles an incisor, but p_1 is just like a minute canine and one can hardly escape the inference that it formerly functioned as a canine and has dwindled because of the loss of the upper canine, which it opposed. *Protoceras* still retains, in the male sex, the large upper canine, which is opposed by $p._1$ and thus abraded upon the posterior surface, but in the females the upper canine is vestigial.

Camelomeryx, gen. nov.

$I.\frac{2}{}$, $C.\frac{1}{}$, $P.\frac{4}{}$, $M.\frac{3}{}$. Upper incisors small, canines stout, but short; a long diastema between $p\frac{1}{}$ and $p\frac{2}{}$. Premolars and molars closely

resembling those of the preceding genus, but molars with larger external buttresses. Forehead broad and short, sagittal crest long; temporal ridges confined to frontals. Posterior nares farther back than in *Merycodesmus* and palatal notches absent.

In this genus the superior dentition is, except in the character of the incisors, very similar to that of *Merycodesmus*, but the shape of the forehead, the cranium and the hinder part of the palate are very different. In the absence of the lower jaw, it is not practicable to determine finally whether this form is congeneric with *Leptotragulus*, but the character of the upper premolars leads me to believe that it will prove to be quite distinct.

Camelomeryx longiceps, sp. nov.

Size, small; cranium long and slender; orbits small and widely open behind; postorbital processes of frontals extended transversely, but little decurved.

Measurements.

Upper dentition, length I 1 to M 3	0.062
" canine, ant.-post. diameter	.005
" canine, transverse diameter	.003
" premolar-molar series, length	.051
" premolar series, length	.029
" molar series, length	.021
" M 1, length	.0055
" M 1, width	.0075
" M 2, length	.007
" M 2, width	.010
" M 3, length	.0085
" M 3, width	.0115

That *Camelomeryx* and *Merycodesmus* are nearly allied genera will be at once apparent from the foregoing description. Whether the former is the ancestor of some White River genus, such as *Hypertragulus*, or whether it is a mere variant of *Merycodesmus* and without permanent phylogenetic significance, must await the decision of more complete material.

OROMERYX Marsh.

Oromeryx Marsh, *Amer. Journ. Sci.*, third series, Vol. xiv, p. 364 (*nomen nudum*).

Oromeryx Marsh, *Amer. Journ. Sci.*, third series, Vol. xlviii, p. 269.

No representative of this genus has yet been detected in the Princeton collection; it may be distinguished from the preceding genera by two principal characters. According to Marsh, "there is no diastema in the dentition," and in the second place, his figure shows that the upper molars, especially m $\frac{3}{}$, have a subovate crown, due to the much greater transverse breadth in the anterior than in the posterior half.

PROTOREODON Scott and Osborn.

Agriochœrus Marsh (non Leidy), *Amer. Journ. Sci.*, third series, Vol. ix, p. 250.

Eomeryx Marsh, *ibid.*, Vol. xiv, p. 364 (*nomen nudum*).

Protoreodon Scott and Osborn, PROC. AMER. PHIL. SOC., 1887, p. 257.

Eomeryx Marsh, *Amer. Journ. Sci.*, third series, Vol. xlviii, p. 266.

The collection contains a large number of specimens appertaining to this genus, and adds very materially to our knowledge of it, but as the newly acquired individuals only confirm the conclusion previously reached, that this genus is ancestral to the *Oreodontidæ* of the Oligocene and Miocene, description of the new material will be reserved for the extended paper.

AGRIOTHERIUM gen. nov.

Premaxillaries reduced and upper incisors small; upper canine large, recurved and trihedral; premolars simple and thick transversely; $p\frac{1}{}$ caniniform; $p\frac{2}{}$ implanted by three fangs, but has no deuterocone; deuterocone of $p\frac{4}{}$ conical, not crescentic; molars like those of *Protoreodon*, but with outer crescents of superior molars more concave, and more prominent median buttress, into which median valley extends. Cranium relatively longer and face shorter than in *Protoreodon* and postorbital processes of frontals shorter.

This genus is evidently very close to *Protoreodon*, but may be distinguished from it by the reduced premaxillaries, the smaller incisors, the simpler premolars and the more concave outer lobes of the upper molars, as well as by the longer cranium, shorter face, and less prominent postorbital processes.

Agriotherium paradoxicum, sp. nov.

Skull about equal to that of *Oreodon gracilis* in length, but much more depressed; mandible stout and chin steeply inclined.

Measurements.

Skull, length on basal line	0.131
" width across zygomata	.077
Length occ. crest to ant. border of orbit	.085
" ant. border orbit to prmx	.051
Mandible, height of condyle	.048
" depth at m.$\frac{2}{2}$	.025
Upper premolar-molar series, length	.0525
" premolar series, length	.029
" molar series, length	.024
" canine, ant.-post. diameter	.006
" canine, transverse diameter	.006
" P 1, length	.0075
" P 2, length	.0065
" P 3, length	.007
" P 3, width	.006
" P 4, length	.006
" P 4, width	.0085
" M 1, length	.075
" M 1, width	.009
" M 2, length	.008
" M 2, width	.011
" M 3, length	.009
" M 3, width	.012
Lower P 3, length	.007
" P 3, width	.003
" P 4, length	.0075
" P 4, width	.004
" molar series, length	.027
" M 1, length	.007
" M 1, width	.0055
" M 2, length	.008
" M 2, width	.006
" M 3, length	.012
" M 3, width	.007

The differences between *Protoreodon* and *Agriotherium* are such as strongly to suggest the inference that, while the former is the ancestor of the Oreodonts, the latter stands in a similar relation to the Agriochœrids. This determination can, at present, be only provisional, until more is learned concerning the foot-structure of the present genus. At all events, if *Agriotherium* be not the desired ancestral form, we may feel confident that that form, when found, will prove to be of a very similar character.

HYOMERYX Marsh.

Amer. Journ. Sci., third series, Vol. xlviii, p. 268.

This genus, which is described as having no upper incisors, I have not seen. It differs from the two preceding genera not only in the loss of the upper incisors, but also in the form of the upper molars, which have far less concave external crescents, and less prominent outer buttresses.

The study of the Uinta Selenodonts lends much strength to the opinion expressed by various writers, that the Oreodonts are related to the Tylopoda. It now appears likely that this family leads back either to *Homacodon* of the Bridger, or to some nearly allied form of the same family. If this be true, we shall then have the more extended generalization, that all of the indigenous North American Selenodonts belonged to the Tylopoda and that this suborder has had a much more extended and varied development than we have hitherto supposed. While this conclusion is already extremely probable for the other families, we have yet to find the direct forerunners of *Protoreodon* and *Agriotherium* before it can be established for the Oreodonts and Agriochœrids.

Stated Meeting, April 1, 1898.

Mr. FREDERICK PRIME in the Chair.

Present, 12 members.

Correspondence was submitted and donations reported.

Dr. Morris, on behalf of the Curators, exhibited a *facsimile* of the Declaration of Independence in the handwriting

of Thomas Jefferson, which, with some accompanying memoranda also in their possession, they have had framed for better preservation.

It is evidently the same as that contained in Vol. iv of Randolph's *Memoirs of Jefferson*, and likewise from the same plates as (previous to their completion) the proof copy in a black frame now in the Library, and identified as such by Mr. Corbin, of the American Bank Note Company, by marks of the unfinished condition of one of the plates, absence of notes "Dr. Franklin's handwriting" and "Mr. Adams' handwriting" from margin, as well as by the texture of the paper.

This *fac-simile* now framed for preservation has at commencement the marks in ink "Draft 'A'"; the handwriting of which is pronounced by Mr. F. J. Dreer to be that of John Vaughan, an interesting letter from whom, as to the Jefferson-Lee MS. is in Mr. Dreer's collection at the Historical Society's hall, also an alleged *fac-simile* of the originally signed document on quarto paper, otherwise closely resembling this Draft A, but lithograph, said to be copied from MS. in Department of State at Washington; none such is known there. This framed *fac-simile* has also the following in leadpencil, "these leadpencil marginal entries make Draft B—this Draft B is copy sent to Lee by Jefferson."

Mr. Dreer also identifies the marginal notes as to handwritings of Dr. Franklin and Mr. Adams, as the *fac-simile* of Jefferson's handwriting, so that the latter must have annotated the copy used in preparing Jefferson's *Memoirs* by Randolph.

He also finds in his diary of May 13, 1889, as follows:

"Met Major Frank Etting, Fred. D. Stone, Simon Gratz and Mr. Philip S. P. Connor, at the Philosophical Society rooms to compare and determine who wrote the interlined and marginal notes on the proof copy of the Declaration of Independence." This explains the attached note of F. M. E. of the same date.

A copy is also given of letters of Jefferson and R. H. Lee,

the latter dated from Chantilly, his residence in Virginia, as to the Jefferson-Lee document.

DR. HAYS asked if this is the *fac-simile* copy which Dr. Morris took out of the Librarian's desk last autumn under the impression that it was an unknown, original, Jefferson autograph draught of the Declaration of Independence.

DR. MORRIS replied that it was the same copy.

DR. HAYS stated that this *fac-simile* is catalogued on page 573 of the printed catalogue of the Society's library, and had the library officials had any intimation of Dr. Morris' intention to take it he would have been informed that it was only a *fac-simile* of the well-known rough draught, which has been reproduced in almost every edition of Jefferson's works. It has all the appearances of having been torn out of a copy of Randolph's edition and possesses no special value.

MR. EDMUNDS asked where the original of this *fac-simile* is.

DR. MORRIS replied that it is in the possession of the University of Virginia.

DR. HAYS expressed surprise at this statement, as he was not aware that the University of Virginia had ever possessed it. The United States claimed to have acquired it fifty years ago, with the other Jefferson papers from the Jefferson heirs, who, by the terms of their sale to the United States, agreed to convey "all the papers and manuscripts" of Thomas Jefferson in their possession. In the Department of State at Washington there is framed under glass and kept in a fireproof safe a manuscript which is said to be this original.[1]

Mr. James Douglas presented an obituary notice of Dr. Thomas Sterry Hunt.

The following communications were presented:

By Prof. Edward H. Williams, Jr., "Notes on Kansan Drift in Pennsylvania."

By Mr. John Van Denburgh, "Herpetological Notes."

By Dr. I. Minis Hays, "A Note on the History of the

[1] Dr. Hays has since verified the statement that this original is in the Department of State at Washington.

Jefferson Manuscript Draught of the Declaration of Independence in the Library of the Society."

By Mr. S. F. Peckham, "The Genesis of Bitumens, as Related to Chemical Geology."

Pending nominations Nos. 1432 and 1451 to 1457 and new nominations Nos. 1458 to 1464 were read.

The Society was adjourned by the presiding member.

NOTES ON KANSAN DRIFT IN PENNSYLVANIA.

BY PROF. EDWARD H. WILLIAMS, JR.

(*Read April 1, 1898.*)

The writer uses the terms Kansan and Wisconsin to represent respectively the furthest ice advance and the first great moraine of recession which was delimited by Lewis and Wright, without accepting the differences in age claimed by some authorities. His work since 1893 has been a study and mapping of the Kansan deposits in this State, and papers have been published from time to time, copies of which have been deposited in the library of this Society.

At the Buffalo meeting of the American Association for the Advancement of Science, in 1896, the writer presented a few notes on the work of the preceding months and claimed that the ice which covered the northern part of this State originated at two centres, an eastern and a western, as the lithological burden on either side of the apexes of both Kansan and Wisconsin deposits differed widely in character, kinds and amount of crystalline and clastic material. This claim was further substantiated by the fact, shown in the sketch accompanying this paper, that the apex of the earlier line of drift had been overridden by the latter, while, had the latter been a moraine of recession only, there should have been a continuous Kansan border.

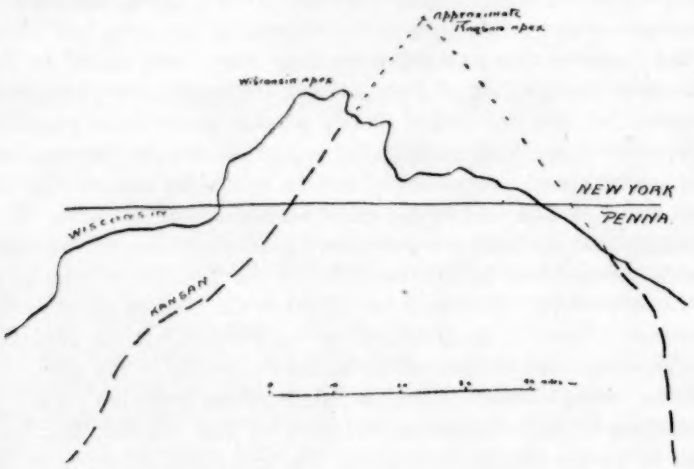
To these claims the writer now wishes to add two more. First, that the powers of the two bodies of ice on either side of the apex were unequal, as the eastern Kansan border will average thirty

miles in width, while the western averages but six. This is in accordance with the deductions of the late Prof. James D. Dana, in the last paper he wrote on glaciation, in attempting to account for the wide difference between the eastern and western deposits. It is well known that Mr. Upham began his work in the east and held to the theory of a single glacial epoch. After work in the west he accepted that of two or more periods. On his return to the east he returned to his first opinion. This is an epitome of the wide difference in appearance between the few strong moraines of the east and the multiplicity of the deposits of the west, and Prof. Dana theorized that such difference must have been caused by the abundant precipitation of the east and the scanty precipitation of the west, so that the deficit of dry seasons would bear a smaller proportion to the total precipitation in the east than in the west, and the strength and persistence of the ice at certain latitudes in the east would be balanced by the many fluctuations of the west. The strength thus predicted for the eastern glacier is shown by the wider margin found and by the variation in the position of the apex. While the western Kansan ice retreated to the position taken by the Wisconsin margin, the relaxation of the pressure was accompanied by an advance of the eastern ice across the region of the apex.

The second claim for a double origin substantiates the theory, as there was found in the summer of 1897, at East Warren, Pa., forty feet below the original surface and 100 feet above the water of the Allegheny river, a rolled piece of native copper as long and thick as the finger, in a lenticule of dense till which resisted the pick. The matrix of clay had preserved the copper from oxidation to such an extent that its surface was still smooth, and with it were found fresh rolled and glaciated crystalline pebbles and local angular clastics. This lenticule was about 120 feet above the rock surface, as shown by a neighboring well section, and the original thickness of glacial deposit was thus 160 feet. This find shows that the western ice traversed the region of the great lakes in a southeastern direction and proves that we had a meeting of two ice sheets near Salamanca, N. Y. The variations in strength and the varying number of moraines of the eastern and western glaciers are thus satisfactorily settled in a simple manner. It remains to say that the writer was unaware at the time he first made the claim for two origins that Prof. Wright had surmised the same (*Ice Age*, p. 443) from the symmetry of the moraine delimited by Mr. Lewis and

himself with respect to origins near Lake Superior and Labrador. It was a surmise only, as he states that these need not have been origins, and the ice may have traversed them from some more northern point. The first distinct proof of such difference of origin rests with the writer.

This glacial deposit of East Warren disposes, also, of another question which has been much debated, whether there was more than one ice age.



The writer has already disposed of the question for eastern Pennsylvania, by showing that the Lehigh and its tributaries acquired their present level in pre-Kansan times. The lenticule at East Warren was about 100 feet above the present Allegheny; but the rock floor, as shown by a well section near, was 120 feet below the lenticule, or twenty feet below the present Allegheny. Other well sections show that this floor is dipping steeply and toward the west, so that it reaches greater depths below the present river level. This lenticule was forty feet below the old surface at this point; but this surface rose on going west, so that in a distance of fifty feet it was sixty feet higher. On this old surface the various geologists have collected material and all agree that it represents the oldest glacial period. This surface is one of the alleged "rock shelves" of the region; but is instead a dump in slack water and shown by well sections to be over 250 feet thick. It is allowed by all that

the surface consists of Kansan drift, and it is also allowed that this surface was last deposited. It follows, therefore, that the earliest, or Kansan, drift was deposited after the Allegheny river had reached its present level. This is but one of hundreds of similar cases found for 200 miles along the Allegheny, and with streams under both glaciers—eastern and western—cut to present levels preglacially, the great antiquity of the ice age falls.

It may be asked, however, how the reversal of streams and cutting of cols are disposed of, as these are matters of considerable certainty.

When we consider that the ice advanced up stream in all cases over the northern Allegheny region, we can see that extreme high water would obtain and the water would pour over the cols into adjacent systems long before the actual presence of the ice at the spot. In fact, the actual presence at a given spot is unnecessary. If we next consider that the advancing ice would confront the loftiest part of our highlands, we can see that it would be aided in its efforts to produce high water by a large snow cap whose ablation would produce torrential conditions in all the drainage systems, and fill those systems with local trash, more or less rolled, which would saw down the cols over which the empounded waters escaped, long before the ice reached the region, and that when the glacier did make its appearance it would discharge into abnormally deep water. We have thousands of evidences from the north to the south of the State, in elevated beach lines, and similar remains, that the water exceeded 1600 feet above tide, and only on the highest mountain tops do we find unmodified till. In all other cases it is ordinary overwash or slack water modifications. The dead slack of the original water is shown throughout the region by the clean iceberg clay which sometimes reaches 100 feet in depth, and underlies all other deposits.

The matters touched upon here will be more fully discussed in the final report of the survey.

A NOTE ON THE HISTORY OF THE JEFFERSON MANUSCRIPT DRAUGHT OF THE DECLARATION OF INDEPENDENCE

IN THE LIBRARY OF THE AMERICAN PHILOSOPHICAL SOCIETY.

BY I. MINIS HAYS, M.D.

(*Read April 1, 1898.*)

As the precise historic relation of the Jefferson manuscript draught of the Declaration of Independence, possessed by this Society, to the document as adopted by the Congress, has been involved in some indefiniteness, it seemed desirable to collect and carefully examine all the information available on the subject.

The draught was acquired by the American Philosophical Society seventy-three years ago and the following entry appears in its Donation Book:

"1825, August 19.

"The draught of the Declaration of Independence originally presented to Congress. This venerable document was sent to R. H. Lee (the mover of the resolution of Independence) by Thos. Jefferson (in whose handwriting it appears to be, with the alterations made previous to the adoption by Congress) on the 8th [*sic*] July 1776 & has remained in Mr. Lee's family until the present time when his Grandson, R. H. Lee, gave it to the A. P. Soc'y to be added to the Documents presented on 17 June.[1] It was accompanied by a copy of Mr. Jefferson's letter enclosing it.

"*Donor.* Richd. Henry Lee, grandson of R. H. Lee by hands of G. W. Smith."

On the margin of the page is written:

"Received from the hands of Richard Henry Lee, Esq., by me and in pursuance of his request presented to the American Philosophical Society.

"GEORGE W. SMITH."

[1] The autograph correspondence of R. H. and A. Lee.

Below the entry of the donation and on the same page, the following certificate is written:

"Having examined the above Draught we certify it to be in the handwriting of Thos. Jefferson.

"Philad. 9 Sep. 1825.

"W. SHORT,
"EDWARD COLES,
"JN. VAUGHAN."

"Who has been for 40 yrs.
Correspt. of T. J.

The document makes four, closely written pages on two sheets of white foolscap measuring $12\frac{1}{2} \times 7\frac{7}{8}$ inches.

It appears to be a fair copy, originally without interlineations or erasures, of the Declaration as adopted by the Committee. The omissions made by the Congress sitting in Committee of the Whole are indicated by underscoring the parts omitted and where insertions were made by the Congress they are, for the most part, written on the margin, in a different hand from the body of the text, and, as will be subsequently seen, after the copy had been received by Lee.

The document was originally folded in four for convenience of transmittal and of filing, and at the top of the outside fold of the last sheet is written the following endorsement:

"Declaration of Independence as reported to Congress, July 1777" [*sic*].

At the bottom of the fourth and last page is written:

"The endorsement is in the handwriting of R. H. Lee, the alterations in that of Arthur Lee."

Jefferson's letter transmitting this manuscript copy of the Declaration to Richard Henry Lee, is as follows:

"TO RICHARD HENRY LEE:[1]

"PHILADELPHIA, July 8th, 1776.

"*Dear Sir*:—For news, I refer you to your brother,[2] who writes on that head. I enclose a copy of the Declaration of Independ-

[1] From Lee's *Life of R. H. Lee*, Vol. i, p. 275.

[2] Presumably Francis Lightfoot Lee, who was also a delegate from Virginia to the Congress and one of the Signers of the Declaration.

ence, as agreed to by the House, and also as originally framed. You will judge whether it is better or worse for the critics. I shall return to Virginia after the 11th of August. I wish my successor may be certain to come before that time: in that case, I shall hope to see you, and not Wythe, in convention, that the business of government, which is of everlasting concern, may receive your aid. Adieu, and believe me to be your friend and servant."

Jefferson evidently thought that the critics had not improved the document and so Lee understood him; for in his reply,[1] he says:

"CHANTILLY, 21 July, 1776.

"*Dear Sir:*

"I thank you much for your favor and its inclosures by this post, and I wish sincerely, as well for the honor of Congress, as for that of the States, that the manuscript had not been mangled as it is. It is wonderful, and passing pitiful, that the rage of change should be so unhappily applied. However, the *Thing* is in its nature so good that no Cookery can spoil the Dish for the palates of Freemen.

* * * * * * * * *

"It will always make me happy to hear from you because I am sincerely your affectionate friend,

"RICHARD HENRY LEE."

R. H. Lee, Jr., in his *Life* of his grandfather (p. 175) says of the copy thus enclosed, "The original was carefully preserved by Mr. Lee, not only for the interest he felt in its history, but for the great respect and warm friendship he felt for Mr. Jefferson. It has been as carefully preserved by his family, and finally committed to the author."

In this connection it should be recalled that the Virginia Convention, which convened at Williamsburg on the 6th of May, 1776, unanimously adopted on the 15th of the same month a preamble and resolutions, which were prepared by Pendleton, offered by Thomas Nelson, Jr., and powerfully advocated by Patrick Henry, to whom R. H. Lee wrote from Philadelphia on April 20th, exhorting him to propose in the Convention a separation from the mother country: "Ages yet unborn and millions existing at present," Lee wrote, "may rue or bless that assembly on which

[1] *Jefferson's MS. Papers*, 2d series, Vol. 51, 12, Library of Department of State, Washington.

their happiness or misery will so eminently depend."[1] The preamble enumerated in strong terms the wrongs done to the United Colonies; the King's proclamation declaring them to be out of the protection of the Crown; and that there was no alternative but abject submission or a total separation. The first resolution was as follows:

"That the delegates appointed to represent this colony in the General Congress be instructed to propose to that respectable body to declare the United Colonies free and independent States, absolved from all allegiance to, or dependence upon, the crown or parliament of Great Britain, and that they give the assent of this colony to such declaration, and to whatever measures may be thought proper and necessary by the Congress for forming foreign alliances, and a confederation of the colonies, at such time and in the manner as to them shall seem best; *Provided*, the power of forming government for, and the regulations of the internal concerns of each colony, be left to the respective colonial legislatures."[2]

Richard Henry Lee, by appointment of the delegates from Virginia and in accordance with the instructions conveyed in this resolution, moved in the Congress on June 7, 1776:

"That these united colonies are, and of right ought to be, free and independent States; that they are absolved from all allegiance to the British crown, and that all political connection between them and the State of Great Britain is, and ought to be totally dissolved."

The resolution was seconded by John Adams, and was debated from the 7th to the 10th of June, Lee strenuously urging every argument in support of his motion. The Congress finally on the 10th of June ordered the further consideration of the resolution of independence to be postponed to the first day of July and "in the meanwhile, that no time be lost, in case the Congress agree thereto, that a committee be appointed to prepare a declaration to the effect of the said first resolution."

On the evening of that day, the 10th, Lee received by express intelligence of the dangerous illness of his wife at her home in Virginia. He immediately asked for leave of absence and left Philadelphia on the 11th, before the Committee was elected to draught

[1] *The Virginia Convention of 1776*, by Hugh Blair Grigsby, Richmond, 1855, p. 8.

[2] *Ibid.*, p. 17.

a declaration of independence. Lee's absence, which was of necessity to be of uncertain duration, precluded his being selected to serve on this Committee, in accordance with parliamentary practice, and as the resolution was offered under instructions from the Virginia colony, another of its representatives, Thomas Jefferson, was selected to head the Committee, with, as the other members, John Adams, the seconder of the resolution in the Congress, Franklin, Sherman and R. R. Livingston, the last representing those who thought that the time had not yet arrived for such an extreme measure.[1]

The Committee unanimously requested Jefferson to prepare the draught, but before reporting it to the Committee he communicated it separately to Dr. Franklin and Mr. Adams, because he says[2] "they were the two members whose judgments and amendments I wished most to have the benefit before presenting it to the Committee. . . . . Their alterations were two or three only, and mostly verbal. I then wrote a fair copy, reported it to the Committee, and from them unaltered, to Congress."

Jefferson reported the draught to the Congress on Friday, June 28, when it was read and ordered to lie on the table. On July 1, the Congress resolved itself into a Committee of the Whole and resumed the consideration of the original motion of Lee "respecting independency," which, after being debated through the day, was carried and was reported to the House and further consideration postponed to July 2, when it was adopted. The Congress, sitting in Committee of the Whole, then proceeded to the consideration of the Declaration reported by Jefferson, which had been referred to it on July 1, and examined, debated and amended it during the 2d, 3d and 4th of July.

Jefferson, in his *Autobiography*, says:[3] "The pusillanimous idea that we had friends in England worth keeping terms with still haunted the minds of many. For this reason, those passages which conveyed censures on the people of England were struck out, lest they should give them offense. The clause, too, reprobating the enslaving the inhabitants of Africa was struck out in complaisance

[1] See E. Rutledge to John Jay, June 8, 1776, *Jefferson's Autobiography*, Ford's *Jefferson*, Vol. i, p. 19.

[2] Jefferson to J. Madison, August 30, 1823, Ford's *Jefferson*, i, p. 26. On this point see also *Autobiography of John Adams*, quoted by Ford, *ibid*, i, 24.

[3] Randolph's *Jefferson*, Vol. i, p. 15.

to South Carolina and Georgia, who had never attempted to restrain the importation of slaves, and who, on the contrary, still wished to continue it. Our Northern brethren also, I believe, felt a little tender under these censures, for though their people had very few slaves themselves, yet they had been pretty considerable carriers of them to others."

In the afternoon of the fourth the debate was closed and the Declaration as agreed to in the Committee of the Whole was reported by Mr. Harrison as Chairman of the Committee of the Whole and was adopted by the House.[1]

With the view of ascertaining more definitely the historic relation of the copy in the possession of this Society to the original draught, Mr. John Vaughan, the Librarian of the Society, upon the receipt of the document from Mr. Lee, wrote to Mr. Jefferson, asking him concerning this point, and received the following reply:[2]

"To JOHN VAUGHAN, ESQ.

"MONTICELLO, September 16, 1825.

"*Dear Sir*:—I am not able to give you any particular account of the paper handed you by Mr. Lee, as being either the original or a copy of the Declaration of Independence, sent by myself to his grandfather. The draught, when completed by myself, with a few verbal amendments by Dr. Franklin and Mr. Adams, two members of the Committee, in their own handwriting, is now in my own possession, and a fair copy of this was reported to the Committee, passed by them without amendment, and then reported to Congress. This latter should be among the records of the old Congress; and whether this or the one from which it was copied and now in my hands, is to be called the original is a question of definition. To that in my hands, if worth preserving, my relations with our University gives irresistible claims.

"Whenever in the course of the composition, a copy became overcharged, and difficult to be read with amendments, I copied it fair, and when that also was crowded with other amendments, another fair copy was made, etc. These rough draughts I sent to

[1] For a full review of the circumstances leading up to the Declaration and its adoption and signing, see Frothingham's *Rise of the Republic of the United States*, Boston, 1872.

[2] *The Writings of Thomas Jefferson*, edited by H. A. Washington, Vol. vii, New York, 1854, pp. 409, 410.

distant friends who were anxious to know what was passing. But how many, and to whom, I do not recollect. One sent to Mazzei was given by him to the Countess De Tessie (aunt of Madame de Lafayette) *as the original*, and is probably now in the hands of her family. Whether the paper sent to R. H. Lee was one of these, or whether, after the passage of the instrument, I made a copy for him, with the amendments of Congress, may, I think, be known from the face of the paper. The documents Mr. Lee has given you must be of great value and until all these private hoards are made public, the real history of the revolution will not be known."

On April 24, 1840, in response to Mr. Vaughan's request Richard Henry Lee sent him the following statement:

"The Draught of the Declaration of Independence in the Athenæum [American Philosophical Society][1] in Philadelphia, in the handwriting of Mr. Jefferson, came into my possession, together with the MSS. of Richard Henry Lee from Francis L. Lee, one of the sons of R. H. Lee; and was presented by me to the Athenæum [American Philosophical Society] in Pha.

"The history of this Document, given to me by my father and his brother, as given them by their Father, R. H. Lee derived from Mr. Jefferson, is this, that after alterations had been made in the Committee of the first draught drawn by Mr. Jefferson, *he drew two Draughts, one to be reported to Congress;* and *the other for Richard H. Lee*, which he sent to him enclosed in a letter dated (I think) on the *8th July 1774* [*sic*]. This letter and the draught were carefully kept by R. H. Lee and after his death were as carefully preserved by his sons. Copies of the letter were taken; but the original had been lost, before the MSS. of R. H. Lee came into my hands. The copy which I presented to the Athenæum [American Philosophical Society] with the Draught, was declared to me by the sons of R. H. Lee, to be an exact copy. The Draught being drawn by Mr. Jefferson himself, before the report had been made to Congress, is as much *an Original*, as any other in existence. The interlineations on the Draught were written by Arthur Lee.

"Richard Henry Lee,

"A.D. 1840. Grandson and Biographer of R. H. Lee."

[1] Mr. Lee seems to have confused the American Philosophical Society with the Athenæum, which was a tenant in the building of the former at the time of Mr. Lee's visit to Philadelphia.

A careful study of the Lee manuscript copy in the possession of this Society clearly shows it to be the wording of the draught as reported by the Committee of five to the Congress. There is nothing to indicate whether it was a copy made by Jefferson at the same time that he made the fair copy to be reported to the Congress or later but prior to the writing of his letter of transmittal to Lee on July 8. Nor is there anything to prove whether the underscoring of the parts stricken out by the Congress was done by Jefferson or by some other hand at a later date, although Jefferson seems to have underscored these parts in all the fair copies he subsequently made of which we have knowledge.

Under the circumstances it was natural that Jefferson should send to Lee a copy of the Declaration so soon as it was agreed upon, and it seems therefore probable that when writing a fair copy to report to the Congress, and not anticipating any material alteration of it, he should, also, so as to lose no time, make another copy to send to Lee. As the Congress was sitting in secret session the necessity of maintaining all the safeguards of secrecy as to its pending deliberations prevented his forwarding this copy until after the adoption and promulgation of the Declaration. Then on the 8th of July, when he could, with propriety, send it, he found it necessary, because of the unexpected changes made by the Congress, to enclose also a copy of the text as finally adopted.[1]

Richard Henry Lee, Jr., in *The Life and Correspondence* of his grandfather, says (p. 175), that Jefferson in his letter of July 8, 1776, enclosed a copy of the Declaration as "drawn in the Committee and also a copy of the Declaration as adopted by Congress." This statement, taken in connection with the fact that the marginal notes of the changes by the Congress in this Society's copy were not made by Jefferson, but are in the handwriting of Arthur Lee, who was not in this country at any time during the year 1776, is in entire accord with that made by Jefferson in his letter of transmittal, in which he says, "I enclose a copy of the Declaration of Inde-

[1] I have been unable to ascertain whether the copy of the text as adopted by the Congress was among the Lee papers presented to the University of Virginia, and if so, whether it was saved from the fire which destroyed its Library building in October, 1895. The Lee papers were contained in a trunk which, at the time of the fire, was thrown out of an upper window and broken by the fall. The papers were gathered up into a bundle and it is hoped none were lost, but until the new Library building is completed they cannot be examined.

pendence as agreed to by the House, and also as originally framed" and with Lee's reply thanking him for the "inclosures."

If this manuscript copy had been made after the 4th of July it seems most likely that Jefferson would have copied the document as finally adopted by the Congress on that date, or at least would have indicated on the margin all the changes that had been made by the Congress. It also seems probable that the copy of the text as adopted by the Congress, enclosed by Jefferson for purpose of comparison, was a printed copy, as the document was by order of Congress[1] immediately put in print, and on the 5th the President transmitted copies, probably in the form of a broadside, to several assemblies,[2] and it appeared in *The Pennsylvania Evening Post*, for Saturday, July 6, 1776 (Vol. ii, No. 228); had it been another manuscript copy it would have been preserved by Lee with the same care as he gave to the one now in the possession of this Society. The accompanying copy could not have been the copy in the Emmet Collection now in the Lenox Library, hereafter to be referred to, which is said, also, to have belonged to "the Lee family," since that, too, is a copy of the draught as presented by the Committee and not as adopted by the Congress.

The marginal notes showing the additions to the text made by the Congress are evidently written by a different hand from the one that wrote the draught, and according to the endorsement, they were written by Arthur Lee. The handwriting appears to be his and I see no reason to doubt the correctness of the statement. Arthur Lee was in Europe, and had been there for some years, when the Declaration was adopted and did not return until September, 1780.[3] From which it would seem certain that at a date subsequent to this he and R. H. Lee compared the draught written by Jefferson with the document as passed by the Congress and marked the omissions and wrote on the margins the additions.

It is probable that the endorsement on the document was made some years after it was received, which may account for the erroneous date on it of "1777," which error would not be likely to have been made had it been written when received in 1776.

[1] "*Resolved*, That copies of the Declaration be sent to the several assemblies, conventions and committees or councils of safety, and to the several commanding officers of the continental troops; that it be proclaimed in each of the United States, and at the head of the army."

[2] Frothingham, *loc. cit.*, p. 544.

[3] See *Life of Arthur Lee*, by R. H. Lee, Vol. i, p. 164.

The conclusions I had reached concerning the draught belonging to this Society were subsequently confirmed by the following letter, written in the autumn of 1841, from John Vaughan to the Prince de Joinville, a copy of which I have recently found among the Society's unarranged manuscripts.

NOTE RELATIVE TO THE ORIGINAL DRAUGHT OF THE DECLARATION OF INDEPENDENCE OF THE UNITED STATES OF AMERICA, IN THE HANDWRITING OF THOMAS JEFFERSON AND NOW IN POSSESSION OF THE AMERICAN PHILOSOPHICAL SOCIETY AT PHILADELPHIA.

On the 7th day of June 1776 Richard Henry Lee moved in the American Congress "*That America should declare itself Independent of Great Britain;*" this motion was seconded by John Adams. The consideration of this motion was referred to 10th June. On that day Rich. Henry Lee received an account that his Wife was dangerously ill, obtained leave of absence from Congress and went home. On the 10th June, Congress proceeded to the Order of the day, and after some debate, postponed the further consideration of the question to the 1st July; but in order to save time, appointed a Committee to prepare a form of Declaration, to be ready for adoption, if then determined upon. The Committee named consisted of Mess. T. Jefferson, J. Adams, B. Franklin, Sherman & R. R. Livingston. Mr. Jefferson having been appointed Chairman of the above named Committee, it was assigned to him to prepare a Draught of the Declaration, (*the three first named were the most active members.*) The Draught was submitted to the Committee who suggested alterations. Amongst Mr. Jefferson's papers after his death there was found the Copy with the final corrections of his Associates from which a copy has been lithographed and appended to the Memoirs of Jefferson by his Grandson Thomas Randolph and a copy of this is preserved by the A. P. S. in a frame. *From this rough corrected Draught* Thomas Jefferson made Two fair Copies one to be submitted to Congress, as the report of the Committee, and one for Richard Henry Lee, the mover of Declaration, who did not return previous to the 1st July. The fair original Copy intended for Congress was reported to that body by Benjamin Harrison (father of the late President Harrison to whom it had been entrusted) on 1st July. Considerable alterations were made previous to its adoption which took place on 4th July. On

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the 8th July Mr. Jefferson wrote to Mr. Lee as follows. "*I enclose you a copy of the Declaration of Independence as agreed to by the House and also as originally framed.*" This was the Second copy which he had made for Mr. Lee. Mr. Jefferson added "*You will judge whether it is better or worse for the Critics.*". On the suggestion of Mr. Jefferson the Comparison was made by Richard Henry Lee and his Brother Arthur Lee, who drew a black line upon the *original draught proposed by the Committee* under every part rejected by Congress; and in the margin opposite placed the word *out.* This document thus marked is the one possessed by the Am. Philosophical Society.

Sometime after the death of Richard Henry Lee his Grandson, of the same name, wrote the memoirs of his Grandfather, having obtained from his Father and Uncle all the papers and correspondence of his Grandfather with the Eminent Patriots of that day. These memoirs were published in Philadelphia by the Grandson in 1825 with whom I was on terms of intimacy. Whilst publishing he was requested to favour the Am. Philos. Society with the original papers and Documents as soon as he had made use of them. The request was granted and on the 17th June 1825 they were put in possession of the correspondence which is bound up in two Volumes, and on the 19th of August 1825 R. H. L. sent them the original form proposed by the Committee, in the handwriting of Mr. Jefferson, and with the marks thereon made by the two Lees above alluded to. When received it was duly recorded by the Society and Mr. Wm. Short & Mr. Edward Coles who were intimate Friends of Mr. Jefferson and the undersigned (who had been his Correspondent for more than 40 years) Certified on the book of records, that this Document was of the handwriting of Mr. Jefferson; and Mr. George Washington Smith, to whom the delivery was entrusted, certified that he received the whole from Richard Henry Lee the Grandson, with directions to deliver them to the A. P. Society and that he delivered them to the undersigned for the Society.

A copy of this proposed Declaration was published by the Grandson in the memoirs of his Grandfather *the parts left out by Congress being printed in Italics;* several Editions of this *Italicised Copy* of 1825 were published between that year and 1829, when it was republished and Lithographed in similar form in the memoirs of Thomas Jefferson which was first published in that year.

This original draught of the declaration is framed between strong glass Plates so as to be perfectly viewed and examined by those who feel an interest in it. The other Original sent to Congress, cannot be found. The form of Declaration finally adopted, & signed by the Members of Congress exists at Washington in the Department of State, but the *originally proposed form has not been found*, from which circumstance the Document in possession of the Society has with propriety become the sole ORIGINAL DRAUGHT.

France having largely contributed to the obtaining this Independence, the undersigned (in whose charge this document now is) has been led to think that a correct account of it, and the mode by which it was obtained, would be received with some interest by his Royal Highness the Prince de Joinville, who has now an opportunity of examining it. Under this impression this account has been drawn up by

JN. VAUGHAN (aged 85)
Librarian of the Am. Phil. Society.

A letter identical with that to the Prince de Joinville, but with the last paragraph omitted, was also sent by Mr. Vaughan to Mr. J. K. Tefft, of Savannah, on October 5, 1841, and is now preserved in the Emmet collection in the Lenox Library in New York,[1] and previously, on March 27, 1841, he sent a letter of similar purport to Mr. George Combe, of Edinburgh,[2] in which he answers the charge of the *Edinburgh Review* (No. 141, p. 134, 1839) that he had hoaxed Captain Marryatt.

Captain Marryatt, in his *Diary in America*, page 43, Vol. iii, says, "Mr. Vaughan stated to me that he had found the *original draft* of the Declaration of Independence in the handwriting of Mr. Jefferson," and the *Edinburgh Review*, commenting thereon, states that if Captain Marryatt "had ever read that very interesting book (*Memoirs of Jefferson*, Vol. i, p. 17) he would have been aware how grossly a Mr. Vaughan, of Philadelphia, was *hoaxing* him when he talked of having discovered the original draught of the Declaration of Independence." Mr. Combe in his *Notes on the United States* (p. 330) says that "on my second visit to Philadelphia, in March, 1840, Mr. Vaughan enabled me to peruse original

[1] For a copy of this letter I am indebted to the courtesy of Mr. Wilberforce Eames, Librarian of the Lenox Library.

[2] Copy in the Society's collection of MSS.

letters, giving its history from the day it was composed to that on which it was presented to the American Philosophical Society. . . . . Mr. Vaughan exhibited also a letter dated a few weeks before my visit from the son of Richard Henry Lee to himself, expressing his astonishment at the reviewer's remarks."

The letter of R. H. Lee, Jr., above referred to, is preserved in this Society's Manuscript Collections. It is dated, Washington, February 25, 1840, and is in reply to a letter from Mr. Vaughan of January 31, a copy of which is in the Dreer Collection of Autographs in the library of the Historical Society of Pennsylvania. In the course of the letter Mr. Lee says, "The Edinburgh Reviewer was *rather too* learned in our Antiquities. There was no hoax by you, on Marryatt. The paper you shewed him may be called with strict truth *an original Draught.* It is more so than that at Washington. It was written verbatim after the first rough Draft *of the Author*, by the Author himself. It is as much, therefore, *an original* Draught as it well can be, inasmuch as the priority in time as to the first *composed* paper is a matter of no account where the *same author writes at the same* time and occasion the two draughts. Neither are *copies.*"

The following copies of the Declaration of Independence in Jefferson's handwriting are known to exist:

1. The original rough draught showing changes made in Committee of five and also by parentheses and interlineations most of the changes made by the Congress in Committee of the Whole. This appears to have been the last draught made by Jefferson in its course through Committee, and from it he wrote the fair draught to present to the Congress as the report of the Committee and also the copy to send to Richard Henry Lee (2). He apparently used this same draught in Committee of the Whole and noted on it the changes as they were made by the Congress. This draught was first reproduced in *facsimile* in Randolph's *Jefferson.* It was acquired by the Government with the Jefferson papers and is now in the Library of the Department of State.

2. A copy of the draught reported by the Committee of five to the Congress and agreeing closely with the text of the preceding draught. This is one of two copies presumably made on or about the 27th of June, 1776; one was presented to the Congress as the report of the Committee of five and is believed not to have been preserved; the other is the copy in the possession of this Society, and was sent

by Jefferson to Richard Henry Lee on July 8th following, and presented in 1825, by his grandson, of the same name, to the American Philosophical Society, in whose library it is preserved.

3. A copy from the rough draught of the Committee of five, made in 1783 for James Madison and reproduced in *fac-simile* in *The Madison Papers*, Vol. iii., Washington, 1840. Also in the Library of the Department of State.

4. Another copy from the rough draught of the Committee of five, slightly different in wording, inserted by Jefferson in the manuscript copy of his *Autobiography*. This is written on contemporaneous paper and was a copy probably made by Jefferson not long after the adoption of the Declaration. Also in the Library of the Department of State.

5. A copy in the Emmet collection in the Lenox Library, New York. "This is one of several fair copies made by Jefferson from the original rough draught of the Declaration, after its adoption and publication, in which he gave the wording of the text as reported by the Committee, with the portions underlined that were changed or rejected by Congress. After remaining in the possession of the Lee family of Virginia for many years, with other papers of Jefferson, ... was sold by the late Mr. Cassius F. Lee, of Alexandria, to Mr. Elliot Danforth, of New York, from whom Dr. Emmet obtained it."[1]

I have not been able to learn the circumstances under which this copy came into the possession of the Lee family. Dr. Emmet writes me that the only information he "can give is that Mr. Lee stated to me that it was one of the copies Jefferson sent his grandfather, and that it had been sent to some one in lower Virginia by Richard Henry Lee shortly after, and that it was not recovered for many years after."[2]

This copy is without interlineation and does not contain the additions made by the Congress. It is, with some slight exceptions, the text of the document as reported to the Congress.

[1] *Bulletin of the New York Public Library*, 1897, p. 355.

[2] Personal communication, April 16, 1898. It does not seem likely that Jefferson should have sent two similar autographic copies of the Declaration to Richard Henry Lee, and as the history of the copy possessed by this Society is clear and indisputable, it is probable that the Emmet copy came from another source, and Mr. Paul L. Ford, the learned student of Jefferson's works, informs me that he is inclined to believe that it is the copy sent to John Page.

6. A fragment of a copy in the possession of Mrs. Washburn, of Boston.

In addition to these five copies and a fragment of a sixth, Jefferson made, according to Ford,[1] between the 4th and 10th of July, other copies, which he sent to George Wythe,[2] John Page, Edmund Pendleton and Philip Mazzei, who gave his copy, so Jefferson states in his letter to Vaughan, to the Countess de Tessé, of France, but it is not known if these copies are still in existence.

The copy of the draught of the Declaration presented, as its report, by the Committee of five of which Jefferson was Chairman, to the Congress cannot be found and is believed not to have been preserved.[3] It was probably read in the Congress and passed into the hands of the Secretary, who used it in writing in the amendments as they were adopted during consideration of the document in the Committee of the Whole and, upon its adoption by the House, at once sent it to the printer as copy and it was subsequently destroyed.

If these conclusions and the statement previously referred to of R. H. Lee, the elder, to his son, be correct, the historic value of the draught possessed by this Society lies in the fact, apart from its being an autographic copy by Jefferson, that it is one of the two fair copies made at the same time by Jefferson, one to report to the Congress, the other to send to Lee. As the copy presented to the Congress has been lost, the copy sent to Lee, and now belonging to this Society, must be regarded as the authoritative text of the Declaration of Independence as drawn by the Committee of five and reported to the Congress.

[1] *Writings of Jefferson*, ii, p. 42, Note.

[2] This copy was delivered to Mr. Thomas Ritchie, editor of the *Richmond Enquirer*, by Major Duval, the executor of Mr. Wythe's estate, and its text was printed in Niles's *Weekly Register*, July 3, 1813 (Vol. iv, No. 13). Notwithstanding inquiry among Mr. Ritchie's descendants I have not been able to learn whether it is still in existence.

[3] In the "Rough Journal" of Congress kept by the Secretary, Charles Thomson, appears the entry under July 4, "The Declaration being again read was agreed to as follows." Here the printed Declaration, a broadside with the imprint: "Philadelphia: Printed by John Dunlap," is attached by wafers. In the fair copy of the "Rough Journal" the Declaration is written out at length in the same handwriting as the rest of the Journal. See Chamberlain, "The Signing of the Declaration," *Proceedings of Massachusetts Historical Society*, 2d Series, Vol. I, p. 286.

The text of the draught possessed by this Society and a *fac-simile* of it are appended:[1]

[A Declaration by the Representatives of the UNITED STATES OF AMERICA in General Congress assembled.] *In Congress, July 4, 1776, The Unanimous Declaration of the thirteen United States of America.*

When in the course of human events it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth the separate and equal station to which the laws of nature and of nature's god entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.

We hold these truths to be self-evident; that all men are created equal; that they are endowed by their Creator with [inherent and inalienable] *certain unalienable* rights; that among these are life, liberty, and the pursuit of happiness; that to secure these rights, governments are instituted among men, deriving their just powers from the consent of the governed; that whenever any form of government becomes destructive of these ends, it is the right of the people to alter or to abolish it, and to institute new government, laying its foundation on such principles, and organizing its powers in such form as to them shall seem most likely to effect their safety and happiness. Prudence indeed will dictate that governments long established should not be changed for light & transient causes, and accordingly all experience hath shown that mankind are more disposed to suffer, while evils are sufferable, than to right themselves by abolishing the forms to which they are accustomed. But when a long train of abuses and usurpations, [begun at a distinguished period &] pursuing invariably the same object, evinces a design to reduce them under absolute despotism, it is their right, it is their duty, to throw off such government, & to provide new guards for their future security. Such has been the patient sufferance of these colonies, & such is now the necessity which constrains them to [expunge] *alter* their former systems of government. The history of the present king of Great Britain is a history of [unremitting] *repeated* injuries and usurpations, [among which appears

[1] The text is printed in Roman characters. In order to show the changes made by the Congress the parts stricken-out by the Congress are enclosed in [brackets], and the parts inserted by the Congress are printed in *Italics*.

no solitary fact to contradict the uniform tenor of the rest; but] all [have] *having* in direct object the establishment of an absolute tyranny over these states. To prove this let facts be submitted to a candid world, [for the truth of which we pledge a faith yet unsullied by falsehood].

He has refused his assent to laws the most wholesome and necessary for the public good.

He has forbidden his governors to pass laws of immediate & pressing importance, unless suspended in their operation till his assent should be obtained; and when so suspended, he has [neglected utterly] *utterly neglected* to attend to them.

He has refused to pass other laws for the accommodation of large districts of people, unless those people would relinquish the right of representation in the legislature; a right inestimable to them, & formidable to tyrants only.

He has called together legislative bodies at places unusual, uncomfortable, & distant from the depository of their public records, for the sole purpose of fatiguing them into compliance with his measures.

He has dissolved Representative houses repeatedly [& continually], for opposing with manly firmness his invasions on the rights of the people.

He has refused for a long time after such dissolutions to cause others to be elected whereby the legislative powers, incapable of annihilation, have returned to the people at large for their exercise, the state remaining in the meantime exposed to all the dangers of invasion from without, & convulsions within.

He has endeavored to prevent the population of these states; for that purpose obstructing the laws for naturalization of foreigners; refusing to pass others to encourage their migrations hither; & raising the conditions of new appropriations of lands.

He has [suffered the administration of justice totally to cease in some of these states] *obstructed the administration of justice by* refusing his assent to laws for establishing judiciary powers.

He has made [our] judges dependant on his will alone, for the tenure of their offices, and the amount & paiment of their salaries.

He has erected a multitude of new offices [by a self-assumed power] & sent hither swarms of officers to harrass our people, and eat out their substance.

He has kept among us, in times of peace, standing armies [and ships of war,] without the consent of our legislatures.

He has affected to render the military independant of, & superior to, the civil power.

He has combined with others to subject us to a jurisdiction foreign to our constitution[s] and unacknowledged by our laws; giving his assent to their acts of pretended legislation

for quartering large bodies of armed troops among us;

for protecting them by a mock-trial from punishment for any murders which they should commit on the inhabitants of these States;

for cutting off our trade with all parts of the world;

for imposing taxes on us without our consent;

for depriving us *in many cases* of the benefits of trial by jury;

for transporting us beyond seas to be tried for pretended offences;

for abolishing the free system of English laws in a neighboring province, establishing therein an arbitrary government, and enlarging its boundaries so as to render it at once an example & fit instrument for introducing the same absolute rule into these [States] Colonies;

for taking away our charters, abolishing our most valuable laws, and altering fundamentally the forms of our governments;

for suspending our own legislatures, & declaring themselves invested with power to legislate for us in all cases whatsoever.

He has abdicated government here, [withdrawing his governors, &] *by* declaring us out of his [allegiance and] protection, *and waging war against us.*

He has plundered our seas, ravaged our coasts, burnt our towns, & destroyed the lives of our people.

He is at this time transporting large armies of foreign mercenaries, to compleat the works of death, desolation & tyranny, already begun with circumstances of cruelty and perfidy *scarcely paralleled in the most barbarous ages and totally* unworthy the head of a civilized nation.

He has *excited domestic insurrections among us, and has* endeavored to bring on the inhabitants of our frontiers the merciless Indian savages, whose known rule of warfare is an undistinguished destruction of all ages, sexes, and conditions [of existence].

[He has incited treasonable insurrections of our fellow citizens with the allurements of forfeiture & confiscation of our property.]

He has constrained [others] *our fellow citizens* taken captive[s] on the high seas, to bear arms against their country, to become the

executioners of their friends and brethren, or to fall themselves by their hands.

[He has waged cruel war against human nature itself, violating its most sacred rights of life & liberty in the persons of a distant people, who never offended him, captivating and carrying them into slavery in another hemisphere, or to incur miserable death in their transportation thither. This piratical warfare, the opprobrium of infidel[1] powers, is the warfare of the Christian[1] king of Great Britain. Determined to keep open a market where MEN should be bought & sold, he has prostituted his negative for suppressing every legislative attempt to prohibit or to restrain this execrable commerce: and that this assemblage of horrors might want no fact of distinguished die, he[1] is now exciting those very people to rise in arms among us, and to purchase that liberty of which he[1] has deprived them, by murdering the people upon whom he[1] also obtruded them: thus paying off former crimes committed against the liberties[1] of one people, with crimes which he urges them to commit against the lives[1] of another,]

In every stage of these oppressions, we have petitioned for redress in the most humble terms; our repeated petitions have been answered only by repeated injury. A prince whose character is thus marked by every act which may define a tyrant, is unfit to be the ruler of a *free* people [who mean to be free. Future ages will scarce believe that the hardiness of one man adventured within the short compass of twelve years only, to build a foundation, so broad and undisguised, for tyranny over a people fostered and fixed in principles of freedom.]

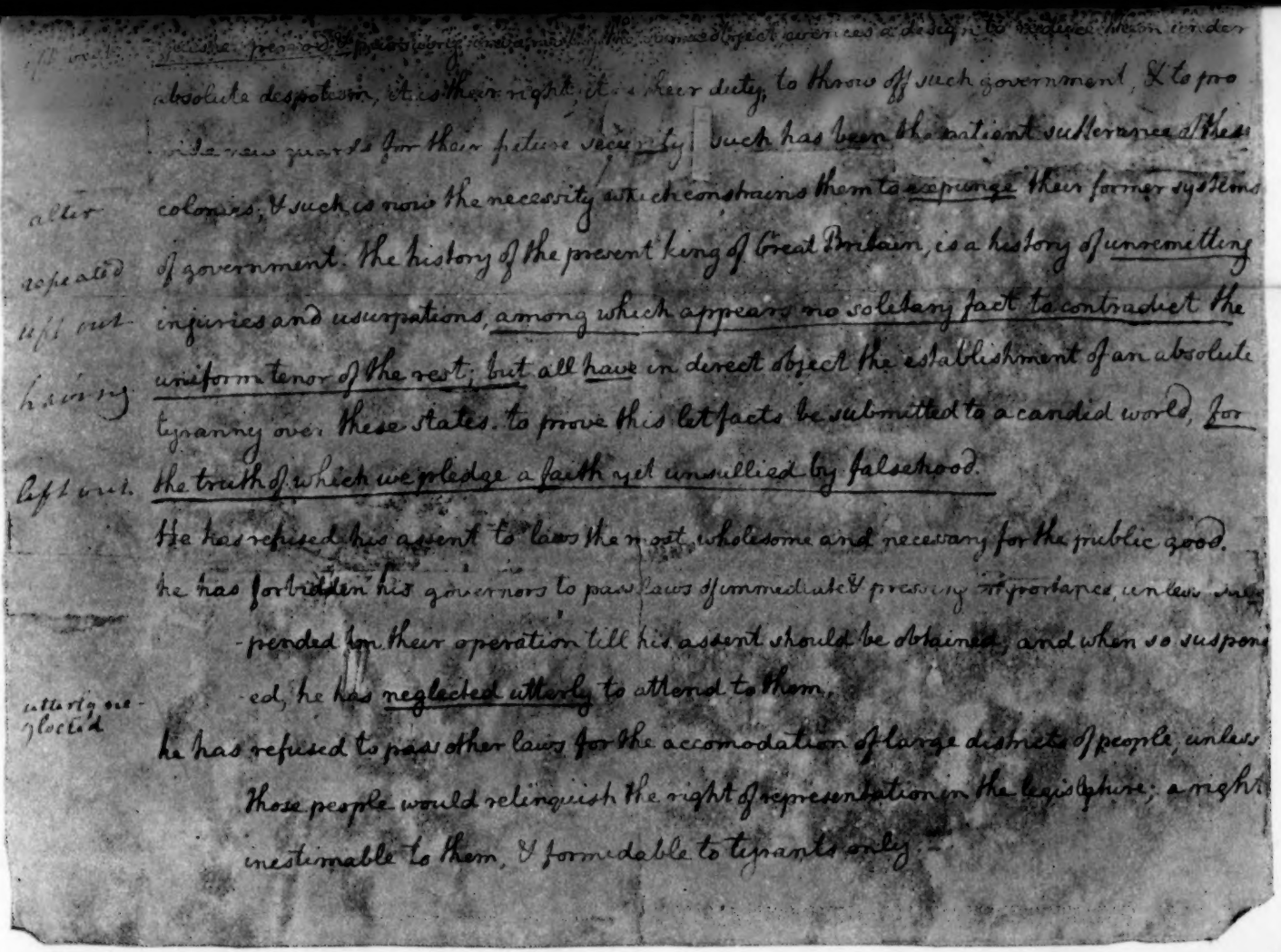
Nor have we been wanting in attentions to our British brethren. We have warned them from time to time of attempts by their legislature to extend [a] *an unwarrantable* jurisdiction over [these our states] *us*. We have reminded them of the circumstances of our emigration and settlement here, [no one of which could warrant so strange a pretension: that these were effected at the expence of our own blood and treasure, unassisted by the wealth or the strength of Great Britain: that in constituting indeed our several forms of government, we had adopted one common king, thereby laying a foundation for perpetual league and amity with them: but that submission to their parliament was no part of our constitution, nor ever in idea, if history may be credited: and] we *have* appealed to their

[1] Underscored in original.

A Declaration by the Representatives of the UNITED STATES OF AMERICA in General Congress assembled.

When in the course of human events it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth the separate and equal station to which the laws of nature & of nature's god entitle them a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.

We hold these truths to be self-evident, that all men are created equal; that they are endowed by their Creator with inherent and inalienable rights; that among these are life, liberty, and the pursuit of happiness; that to secure these rights, governments are instituted among men, deriving their just powers from the consent of the governed; that whenever any form of government becomes destructive of these ends, it is the right of the people to alter or to abolish it, and to institute new government, laying its foundation on such principles and organising it's powers in such form as to them shall seem most likely to effect their safety and happiness. prudence indeed will dictate that governments long established should not be changed for light & transient causes. and accordingly all experience hath shewn that mankind are more disposed to suffer, while evils are sufferable than to right themselves by abolishing the forms to which they are accustomed. but when a long train of abuses and usurpations, begun at a distinguished period & pursuing invariably the same object evinces a design to reduce them under absolute despotism, it is their right, it is their duty, to throw off such government, & to provide new guards for their future security. such has been the patient sufferance of these colonies; & such is now the necessity which constrains them to expunge their former systems of government. the history of the present king of Great Britain is a history of unremitting injuries and usurpations, among which appears no solitary fact to contradict the uniform tenor of the rest; but all have in direct object the establishment of an absolute tyranny over these states. to prove this let facts be submitted to a candid world, for the truth of which we pledge a faith yet unsullied by falsehood.



FAC-SIMILE OF THE JEFFERSON AUTOGRAPH DRAUGHT OF THE DECLARATION OF INDEPENDENCE IN THE POSSESSION OF THE AMERICAN PHILOSOPHICAL SOCIETY.

he has called together legislative bodies at places unusual, uncomfortable, & distant from the depository of their public records, for the sole purpose of fatiguing them into compli-ance with his measures.

he has dissolved Representative houses repeatedly & continually, for opposing with manly firmness his invasions on the rights of the people.

he has refused for long time after such dissolutions to cause others to be elected whereby the legislative powers, incapable of annihilation, have returned to the people at large for their exercise, the state remaining in the mean time exposed to all the dangers of invasion from without, & convulsions within.

he has endeavored to prevent the population of these states; for that purpose obstructing the laws for naturalization of foreigners; refusing to pass others to encourage their migrations hither; & raising the conditions of new appropriations of lands.

he has suffered the administration of justice totally to cease in some of these states refusing his assent to laws for establishing judiciary powers.

he has made our judges dependant on his will alone, for the tenure of their offices, and the amount & paiment of their salaries.

he has erected a multitude of new offices by a self assumed power & sent hither swarms of officers to harrass our people, and eat out their substance.

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he has affected to render the military independant of & superior to, the civil power.

he has combined with others to subject us to a jurisdiction foreign to our constitution & unacknoleged by our laws; giving his assent to their acts of pretended legislation

for quartering large bodies of armed troops among us;

for protecting them by a mock-trial from punishment for any murders which they should commit on the inhabitants of these states;

for cutting off our trade with all parts of the world;

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for cutting off our trade with all parts of the world;

for imposing taxes on us without our consent;

for depriving us of the benefits of trial by jury;

for transporting us beyond seas to be tried for pretended offences;

for abolishing the free system of English laws in a neighboring province, establishing therein an arbitrary government, and enlarging it's boundaries so as to render it at once an example & fit instrument for introducing the same absolute rule into these states;

for taking away our charters, abolishing our most valuable laws, and altering fundamentally the forms of our governments;

for suspending our own legislatures & declaring themselves invested with power to
legislate for us in all cases whatsoever.

out he has abdicated government here, withdrawing his governors, & by declaring us out of his allegiance and protection, & waging war against us.

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he is at this time transporting large armies of foreign mercenaries to compleat the works of death, desolation & tyranny, already begun with circumstances of cruelty & perfidy unworthy the head of a civilized nation.

scarcely paralleled in the most barbarous ages & totally

he has endeavored to bring on the inhabitants of our frontiers the merciless Indian savages, whose known rule of warfare is an undistinguished destruction of all ages, sexes, & conditions of existence.

out he has incited treasonable insurrections of our fellow citizens with the allurements of forfeiture & confiscation of our property.

our fellow subjects he has constrained others taken captives on the high seas, to bear arms against their country, friends & brethren, or to fall themselves by their hands.

he has waged cruel war against human nature itself, violating it's most sacred right of life & liberty in the persons of a distant people, who never offended him, captivating and carrying them into slavery in another hemisphere, or to incur miserable death in their transportation thither. this piratical warfare, the opprobrium of infidel powers, is the warfare of the Christian king of Great Britain. determined to keep open a market where MEN should be bought & sold, he has prostituted his negative for suppressing every legislative attempt to prohibit or to restrain this execrable commerce. and that this assemblage of horrors might want no fact of distinguished die, he is now exciting those very people to rise in arms among us, and to purchase that liberty of which he has deprived them, by murdering the people upon whom he also obtruded them: thus paying off former crimes committed against the liberties of one people with crimes which he urges them to commit against the lives of another.

In every stage of these oppressions we have petitioned for redress in the most humble terms; our repeated petitions have been answered only by repeated injury. a prince

for suppressing every legislative attempt to prohibit or to restrain the exercise of [illegible] assemblage of horrors might want no fact of distinguished die. he now exciting those very people to rise in arms among us, and to purchase that liberty of which he has deprived them, by murdering the people upon whom he also obtruded them: thus paying off former crimes committed against the liberties of one people with crimes which he urges them to commit against the lives of another.

In every stage of these oppressions we have petitioned for redress in the most humble terms; our repeated petitions have been answered only by repeated injury. a prince whose character is thus marked by every act which may define a tyrant, is unfit to be the ruler of a people who mean to be free. future ages will scarce believe that the hardiness of one man adventured within the short compass of twelve years only to build a foundation so broad and undisguised, for tyranny over a people fostered and fixed in principles of freedom.

Nor have we been wanting in attentions to our British brethren. we have warned them from time to time of attempts by their legislature to extend a jurisdiction over these our states. we have reminded them of the circumstances of our emigration and settlement here, no one of which could warrant so strange a pretension: that these were effected at the expence of our own blood and treasure, unassisted by the wealth or the strength of Great Britain: that in consideration [illegible] they should hold one common king, thereby laying a foundation for perpetual league and amity with them: but that submission to their parliament was no part of our constitution, nor ever in idea, if history may be credited: and we appealed to their native justice & magnanimity, as well as to the ties of our common kindred, to disavow these usurpations, which were likely to interrupt our connection & correspondence. they too have been deaf to the voice of justice and of consanguinity, and when occasions have been given them, by the regular course of their laws of removing from their councils the disturbers of our [illegible] they have, by their free election re-established them in power. [illegible] this time too, they are permitting their chief magistrate to send over not only soldiers of our own blood but [Scotch and] foreign mercenaries to invade and destroy us. these facts have given the last stab to agonizing affection, and manly spirit bids us to renounce for ever these unfeeling brethren. we must endeavor to forget our former love for them, and to hold them as we hold the rest of mankind, enemies in war, in peace friends. we might have been a free & a great people together; but a communication of grandeur and of freedom, it seems, is below their dignity. be it so, since they will have it. the road to happiness & to glory is open to us too: we will climb it apart from them, and acquiesce in the necessity which denounces our eternal separation!

We therefore the Representatives of the United states of America in General Congress assembled, do, in the name & by authority of the good people of these states, reject & renounce all allegiance and subjection to the kings of Great Britain, & all others who may hereafter claim by, through, or under them; we utterly dissolve all political con-

we might have been a free & a great people together; but a communication of grandeur and of freedom it seems, is below their dignity. be it so, since they will have it. the road to happiness and to glory is open to us too; we will climb it apart from them, and acquiesce in the necessity which denounces our eternal separation!

We therefore the Representatives of the United states of America in General Congress assembled, appealing to the supreme judge of the world for the rectitude of our intentions, do, in the name & by authority of the good people of these states, reject and renounce all allegiance and subjection to the kings of Great Britain, & all others who may hereafter claim by, through, or under them; we utterly dissolve all political connection which may heretofore have subsisted between us and the parliament or people of Great Britain; and finally we do assert the colonies to be free and independant states, & that as free & independant states they have full power to levy war, conclude peace, contract alliances, establish commerce, & to do all other acts and things which independant states may of right do. And for the support of this declaration we mutually pledge to each other our lives, our fortunes, and our sacred honor.

colonies

The inserted part is in the hand writing of R. H. L. [illegible] [illegible] of Arthur Lee.

native justice & magnanimity, [as well as to] *and we have conjured them by* the tyes of our common kindred, to disavow these usurpations, which [were likely to] *would inevitably* interrupt our connection & correspondence. They too have been deaf to the voice of justice, and of consanguinity; [and when occasions have been given them, by the regular course of their laws, of removing from their councils the disturbers of our harmony, they have by their free election reestablished them in power. At this very time too, they are permitting their chief magistrate to send over not only soldiers of our common blood, but [Scotch and] foreign mercenaries to invade and destroy us. These facts have given the last stab to agonizing affection; and manly spirit bids us to renounce forever these unfeeling brethren. We must endeavor to forget our former love for them, and to hold them as we hold the rest of mankind, enemies in war, in peace friends. We might have been a free & a great people together; but a communication of grandeur and of freedom, it seems, is below their dignity. Be it so, since they will have it. The road to happiness and to glory is open to us too; we will climb it apart from them and] *we must therefore* acquiesce in the necessity which denounces our [eternal] separation [!] *and hold them, as we hold the rest of mankind, Enemies in War, in Peace Friends.*

We therefore the Representatives of the United States of America in General Congress assembled, *appealing to the Supreme Judge of the world for the rectitude of our intentions* do, in the name, & by authority of the good people of these [states, reject and renounce all allegiance and subjection to the kings of Great Britain, and all others who may hereafter claim by, through, or under them; we utterly dissolve all political connection which may heretofore have subsisted between us and the parliament or people of Great Britain, and finally we do assert these] Colonies, *solemnly publish and declare that these United Colonies are and of Right ought* to be free and independant states; *that they are Absolved from all allegiance to the British Crown, and that all political connection between them and the State of Great Britain, is and ought to be totally dissolved;* & that as free & independant states, they have full power to levy war, conclude peace, contract alliances, establish commerce, & to do all other acts and things which independant states may of right do. And for the support of this declaration, *with a firm reliance on the protection of divine Providence,* we mutually pledge to each other our lives, our fortunes, and our sacred honor.

THE GENESIS OF BITUMENS, AS RELATED TO CHEMICAL GEOLOGY.

BY S. F. PECKHAM.

(*Read April 1, 1898.*)

1. On the 5th of February, 1897, a symposium was held at the rooms of the American Philosophical Society in Philadelphia, upon "The Origin and Nature of Petroleum." It was conducted by Profs. S. P. Sadtler and Charles F. Mabery, Dr. D. T. Day, of Washington, D. C., Francis C. Phillips and the writer. While listening to the papers then read, I was impressed with the fact that the discussion proceeded almost wholly without regard to any consideration of the different conditions that probably obtained in that primitive world in which the oldest petroleums found their origin. Prof. Mabery discussed, from the standpoint of pure chemistry, the composition of the petroleums of the Trenton limestone; I, myself, those of the Miocene Tertiary of California; Dr. Sadtler, the extremely interesting experiments that he had made upon the destructive distillation of the glycerides of linseed oil; while Dr. Day discoursed upon the somewhat remote and problematic resultant of certain chemical reactions upon bitumen; and Mr. Phillips presented some exceedingly interesting theoretical considerations concerning "The Genesis of Petroleum and Natural Gas" and "The Occurrence of Petroleum in the Cavities of Fossils." Later reflection has brought very forcibly to my mind considerations that I am led to present as a possible means of reconciling many of the differences that appear in the late discussion of these questions.[1]

2. In view of the general acceptance of the nebular hypothesis, it is unnecessary to establish the fundamental proposition that bitumens, as minerals, are properly considered in their relation to all the other mineral species that have been identified and described as together constituting the earth's crust. The clear distinction of these relations has followed upon many years of research along several lines. It began more than a century ago with the famous discussion waged between the Plutonists and Neptunists, as to whether fire or water had been most active in producing the phe-

[1] PROC. AMER. PHIL. SOC., xxxvi, No. 154.

nomena of rock building. Mineral silicates were then supposed to have crystallized from igneous fusion, and the deposition of sediments to have resulted only in amorphous, uncrystallized rocks. The idea that heat and water together may have produced all of the phenomena that have been attributed to the action of either alone has been of slow growth; but may now be said to be pretty generally accepted, although there are those who refer to the action of heat and of pressure alone phenomena that are without doubt properly the resultant of the action of heat and steam under pressure.

3. The discussions that have proceeded along the three lines of geology, chemistry and mineralogy, have been mainly directed to an elucidation of the problems relating to the formation of the crystalline rocks. To determine, therefore, the nature of metamorphic action and the conditions under which it might take place, was the problem to the solution of which Bischof, Hunt, Delesse, Daubrée and several others of the most gifted chemical geologists of this century devoted themselves.[1] These gentlemen first considered the reactions that according to known chemical laws must follow the cooling of a heterogeneous mixture of the elements composing the earth, in a state of gaseous fluidity, and at a temperature that rendered chemical combination impossible; in other words, a state of complete dissociation. It follows that the most infusible elements would first condense and form a solid nucleus around which would float an ocean, in a state of igneous fusion, of more fusible elements and compounds, while over all would hover an atmosphere containing all the nitrogen and oxygen, the free hydrogen, sulphur and allied elements, with the chlorine and other halogens. As the cooling proceeded the silicon would combine with oxygen and bases, forming both acid and basic silicates, which would constitute a solid crust. The hydrogen and haloids combining would form the haloid acids and the sulphur and allied elements would form oxygen acids, all the hydrogen being oxidized into water, which with the acids would be alternately condensed and evaporated, falling as an acid rain upon the surface of silicated rocks, which in turn

[1] G. Bischof, *Chem. and Phys. Geology*, Cav. Soc. ed. T. S. Hunt, *Chem. and Geolog. Essays.* Delesse, "Essay on Pseudomorphs," *Ann. des Mines*, xii, 509; xiii, 393, 415; xvi, 317–392. *Mem. Acad. de Scien. de France*, xvii. Daubrée, *Comptes Rendus de l'Acad.*, November 16, 1857. *Études et èxperiences synthètique sur le Mètamorphisme*, Paris, 1859.

would emerge from the ocean of water heavy with dissolved chlorides and sulphates, while an atmosphere dense with carbonic acid would help to maintain a temperature that would retard the cooling through vast cycles of geologic time, in the course of which, under conditions entirely different from any now known, vegetable and animal life would appear upon the earth, or, more properly, in the waters that covered the earth.

4. It is very evident that the chemical conditions obtaining in this remote geologic epoch, while not incompatible with the development of life, were, however, very different from those which have prevailed at any time since the advent of any of the higher forms of animals. We have a right to believe that at the dawn of life, of all the elements that enter into the composition of vegetable and animal tissue—carbon, hydrogen, oxygen, nitrogen, phosphorus and sulphur—nitrogen alone was wholly free. Carbon and hydrogen existed in combination with oxygen as carbonic acid and water. Phosphorus and sulphur were oxidized, and in combination with basic elements as salts. The excessive proportion of carbonic acid and aqueous vapor in the atmosphere gave to it the property of transcalesence, by which, while readily penetrated by heat from the sun, it refused to transmit this heat when reflected from objects at the earth's surface. This gave to the atmosphere properties similar to those of a greenhouse, by which so high a temperature was maintained during the coal period that semitropical plants flourished at the poles. At an earlier period, before terrestrial vegetation had removed the carbonic acid from the air, and before the surface of the cooling earth had lost its heat by radiation, the palæozoic (dawn of life) ocean and the land gave support to both vegetable and animal life, at a temperature that at the present time would destroy most organic forms.[1]

5. The strata which form that portion of the earth's crust which has been referred to the palæozoic era, are of enormous thickness and are found in different parts of the world, to present aspects strikingly similar. Messrs. Hall, Billings and Dawson, in North America, Salter and Hicks in England, Angelin in Sweden, and Barrande in Bohemia, have shown that the forms of animal life in that early period were very closely related, if not identical, in these widely separated areas; yet, below these formations, which hold the

[1] W. H. Brewer, *Am. Jour. Sci.* (2), xli, 389.

remains of marine animals, in Bohemia and Sweden if not elsewhere, there is a "region of fucoids," of great thickness, carrying back the dawn of vegetable life to a still more remote epoch.[1] Throughout the last fifty years, successive discoveries of fossils in strata hitherto supposed to be destitute of organic remains, have carried the apparent dawn of life back through successive geological formations, until the azoic (devoid of life) rocks have ceased to be appropriately named, and Mr. Hicks, speaking of the Cambrian fauna of Wales, says, "Though animal life was restricted to these few types, yet at this early period the representatives of the different orders do not show a very diminutive form, or a markedly imperfect state; nor is there an increased number of blind species. The earliest known brachiopods are apparently as perfect as those which succeed them; and the trilobites are of the largest and best developed types. The fact also that trilobites had attained a maximum size at this period, and that forms were present representative of almost every stage of development, ... blind genera along with those having the largest eyes, leads to the conclusion that for these several stages to have taken place numerous previous faunas must have had an existence, and, moreover, that even at this time in the history of our globe an enormous period had elapsed since life first dawned upon it."[2]

6. The formations that contain these earliest palæozoic forms of life are now found for the most part in a crystalline condition; yet, Dr. Hunt affirms, "that the oldest known rocks are stratified deposits of limestone, clay and sands, generally, in a highly altered condition; . . . . it is, however, quite certain that the advent of life in these oldest fossiliferous strata was subsequent to the period of chemical reactions on a cosmic scale."[3] The manner in which these geological formations and parts of formations may have been rendered crystalline has been very exhaustively discussed by Dr. Hunt in his chemical and geological essays. He has shown

[1] James Hall, *Paleontology of New York*, Vol. iii, Introduction. Billings, *Am. Jour. Sci.* (2), xxxii, 232. *Reports Geological Survey of Canada*, v. d. Dawson, *Canadian Naturalist*, v. d. *Reports Geological Survey of Canada*, v. d. Salter and Hicks, *Proc. Geol. Assoc.*, *Quar. Jour. Geolog. Soc.*, v. d. Angelin, *Palæontologica Scandinavica*. Barrande, *Bul. Soc. Geol. de France* (2), xvi, 529–545.

[2] Hicks, *Quar. Jour. Geol. Soc.*, May, 1872.

[3] *Chemical and Geological Essays*, ed. 1875, p. 2.

how fully his conclusions, based almost wholly on theoretical considerations, have been confirmed by the experiments of Daubrée, who was led to investigate this subject, from observing that the action of the alkaline, thermal waters of the spring at Plombières, at a temperature of 60°–70° C., had in the course of centuries given rise to the formation of zeölites and other silicated minerals among the bricks and cement of the old Roman baths.[1] He further shows that at a temperature of 100° C. silicates are produced from a reaction between alkaline silicates and carbonates of lime, magnesia and iron. He says further, "Now the supposed mode of formation of the primitive molten crust of the earth would naturally exclude all combined or intermingled water, while all the sedimentary rocks are necessarily pervaded by this liquid, and are consequently in a condition to be rendered semifluid by the application of heat. . . . . If now, we admit that all igneous rocks, ancient plutonic masses as well as molten lavas, have their origin in the liquefaction of sedimentary strata we at once explain the diversities of their composition. . . . . The presence of fossil plants in the melting strata would generate carburetted hydrogen gases, whose reducing action would convert the sulphurous acid into suphuretted hydrogen; or the reducing agency of the carbonaceous matter might give rise to sulphuret of calcium, which would be, in its turn, decomposed by the carbonic acid or otherwise. . . . . The carburetted hydrogen and bitumen evolved from mud volcanoes, like those of the Crimea and Baku, and the carbonized remains in the *moya* of Quito, and in the volcanic matters of the island of Ascension, not less than the infusorial remains found by Ehrenberg in the ejected matters of most volcanoes, all go to show that fossiliferous sediments are very generally implicated in volcanic phenomena."[2] Again, he states, that in a letter to Sir Charles Lyell, dated February 20, 1836, Sir John F. W. Herschel maintains that with the accumulation of sediments the isothermal lines of the earth's crust must rise, so that strata buried deep enough will be crystallized and metamorphosed, and eventually be raised with their included water to the melting point." Again Dr. Hunt says, "We conceive that the earth's solid crust of anhydrous and primitive rock is everywhere deeply concealed beneath its own ruins, which

[1] *Études et èxperiences synthètique sur le mètamorphisme*, par M. A. Daubrée, Paris, 1859, p. 98; *Ann. des Mines* (5), xiii, 227.

[2] *Essays*, p. 8.

form a great mass of sedimentary strata, permeated by water. As heat invades these sediments, it produces in them that change which constitutes normal metamorphism. These rocks at a sufficient depth are necessarily in a state of igneo-aqueous fusion, and in the event of fracture of the overlying strata may rise among them taking the form of eruptive rocks."[1] He calls the effects produced by such invasion of eruptive masses, local metamorphism. From these extracts from several of Dr. Hunt's essays, it can be easily understood that a struggle has been in progress from the time of the oldest known rocks to the present, between the shrinking and wrinkling crust of a cooling earth and the thickening deposits of sediment accumulating from its erosion.

7. One Sunday in the early summer of 1866, I found myself with Dr. George L. Goodale, now of Harvard University, stranded at a small hostelry, at the San Fernando Pass, near the old Mission of San Fernando, in southern California. The day was very fine and we chose a morning climb to anything the hostelry had to offer; so, mounting our horses, we rode to the eastward over the flood plain of pulverized rock that at some former period had poured out of the great cañon back of where the town of Burbank now stands. We climbed one of the spurs of the San Rafael range to the west of the cañon. We first passed over rounded hillocks of sandy soil which as we ascended became gradually merged into soft fossiliferous sandstone. After a time the effects of heat became manifest. The clam shells and fossil clams, of which there were cart-loads, appeared crystalline, and the iron in the sand was no longer green but red. The sandstones became more dense and the clays were silicated. At length the strata passed into a micaceous gneiss and finally we found the central core of the mountain to be a light-colored fine-grained granite. About half way up, Dr. Goodale found a vertebra of a whale half buried in the sandstone and still very perfect in form, while I found a fossil pine cone that had evidently received some rough usage on the ancient beach. This cone contained some seeds that showed it to be closely allied to the nut pine of New Mexico. The mountain consisted wholly of Tertiary sediments that had been metamorphosed precisely as Sir J. F. W. Herschel had suggested in his letter to Sir Charles Lyell.

[1] *Essays*, p. 9.

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8. It is not alone through a study of the crystalline rocks that the chemistry of the primeval world is interpreted. By a comparison of the kind and amount of salts dissolved in the waters of the primeval ocean that are enclosed in palæozoic strata with the kind and amount of salts dissolved in the waters of the present ocean, Dr. Hunt has shown that from the earliest geologic time until the present, alkaline carbonates derived from the subaërial decomposition of feldspar have been carried into the ocean by streams, and the calcium and magnesium in the ocean have been successively precipitated as carbonates, producing limestones and dolomites, while common salt and calcium sulphate have accumulated in the present ocean, the former in large excess. There is abundant evidence that this palæozoic ocean was hotter than the existing one, as well as more saline, while it is equally evident that during long intervals its sediments carried down vast quantities of the remains of vegetable and animal life. He has further repeatedly shown in what manner these sediments were influenced by the organic matters that were enclosed in them. In his essay on "The Chemistry of Natural Waters," he has shown that argillaceous sediments deprive waters of the organic matter in solution by forming a compound containing an organic radical. He says, "There is reason to believe that alumina is under certain conditions dissolved by waters holding organic acids," and cites melite and pigotite as examples of the compounds formed. He further shows that organic matter in water reduces sulphates to sulphides, producing from soluble sulphates of lime and magnesia carbonates of the basis, with hydrogen sulphide, free sulphur, or a metallic sulphide; the hydrogen sulphide being converted by slow oxidation or combustion, followed by absorption of oxygen directly into sulphuric acid, which is again, when in contact with organic matter, reduced to hydrogen sulphide.

He says with reference to the water of palæozoic brine springs, "In the large amount of magnesium chloride which they contain, these waters resemble the bittern or mother-liquor which remains after the greater part of the sodium chloride has been removed from sea-water by evaporation. . . . . The complete absence of sulphates from many of the waters points to the separation of large quantities of earthy sulphates in the Cambrian strata from which these saline springs issue; and the presence in many of the dolomite beds of the Calciferous sand rock of small masses of gypsum,

abundantly disseminated, is an evidence of the elimination of sulphates by evaporation. . . . . The brines of the valley of the Allegheny river, obtained from borings in the coal formation, are remarkable for containing large proportions of chlorides of calcium and magnesium, though the sum of these, according to the examples given by Lenny, is never equal to more than about one-fourth of the chloride of sodium. The presence of the sulphates of barium and strontium in these brines, and the consequent absence of soluble sulphates, is, according to Lenny, a constant characteristic in this region over an area of 2000 square miles."[1]

Among many other illustrations that might be given of these non-sulphated palæozoic waters, I mention one which was obtained from a boring on Great Manitoulin island in Lake Huron, at a depth of 192 feet, "After passing through the black slates of the Utica formation, and for sixty feet into the underlying Trenton limestone. . . . . It contained no sulphates nor barium nor strontium." Another palæozoic water of a very different character was obtained from a well bored for petroleum at Bothwell, Ontario, in 1865. "At a depth of 475 feet from the surface, and probably at or near the base of the Corniferous limestone, a copious spring was met with of very sulphurous water and a little petroleum." The water contained sulphate of calcium and sulphides of sodium and hydrogen. Waters apparently similar are pumped from several of the oil wells in the vicinity. "The sulphurous impregnation is doubtless to be ascribed to the reducing action of hydrocarbonaceous matter upon the sulphates which the waters contain."[2]

9. A brief examination of the superposition of the palæozoic and earlier formations of North America will show the Laurentian, embracing the oldest known rocks of the globe, outcropping from the coasts of Labrador to Lake Superior and over a large area in northern New York. Associated with this system is the Norian, which is characterized by a great development of opalescent feldspars. Above these are the Green Mountain series, an inferior part of the Lower Silurian, which corresponds wholly or in part to the Huronian system of Canada and the region about Lake Superior. Above them are the White Mountain series, which are Upper Silurian and perhaps Devonian. These formations constitute for the most

[1] Bischof, *Chem. and Phys. Geol.*, i, 337. Hunt, *Chem. and Geol. Essays*, p. 121, ed. 1875. *Am. Jour. Sci.*, March, July and Sept., 1865.

[2] *Essays*, 158–163, ed. 1875.

part the rocks of Canada, New England, eastern New York and the eastern slope of the Alleghenies southward through New Jersey, Pennsylvania and Virginia. Speaking of these rocks, Dr. Hunt says, "In the oldest known of them, the Laurentian system, great limestone formations are interstratified with gneisses, quartzites and even with conglomerates. All analogy, moreover, leads us to conclude that, even at this early period, life existed at the surface of the planet. Great accumulations of iron oxide, beds of metallic sulphides and of graphite, exist in these oldest strata, and we know of no other agency than that of organic matter capable of generating these products.[1] . . . . Bischof had already arrived at the conclusion, which in the present state of our knowledge seems inevitable, 'that all the carbon yet known to occur in a free state can only be regarded as a product of the decomposition of carbonic acid, and as derived from the vegetable kingdom.' He further adds, 'living plants, decomposed carbonic acid, dead organic matters, decomposed sulphates, so that, like carbon, sulphur, appears to owe its existence in the free state to the organic kingdom.' As a decomposition (deoxidation) of sulphates is necessary to the production of metallic sulphides, the presence of the latter, not less than of free sulphur and free carbon, depends on organic bodies; the part which they play in reducing and rendering soluble the peroxide of iron, and in the production of iron ores, is, moreover, well known."[2]

Rocks of the Lower Cambrian in Great Britain as well as in North America are well known to exhibit carbonaceous remains. Of the former it is said, "They occasionally hold flakes of anthracite, and small portions of mineral pitch exude from them in some localities." The rocks of the Malvern hills contain fucoids. In the Quebec series on the south shore of the St. Lawrence, Hunt describes the occurrence of a carbonaceous substance, "entirely distinct from coal, which occurs in fissures, sometimes in the interstices of crystalline quartz. It is an insoluble hydrocarbonaceous body, brilliant, very fragile, giving a black powder, and results apparently from the alteration of a once liquid bitumen."[3] Similar material

[1] On the north shore of Lake Superior, I have found spherical concretions of graphite occuring in a rock that is apparently eruptive.

[2] *Essays*, pp. 301, 302. *Am. Jour. Sci.*, 1871.

[3] *Essays*, pp. 382, 396. W. Hodgson Ellis, "Analysis of Some Precarboniferous Coals," *Chem. News*, lxxvi, 186, Oct. 15, 1897.

often lines cavities in the limestone in Herkimer county, New York, and not only sometimes encloses crystals of quartz, but is often enclosed in quartz crystals. These limestones are not crystalline.

Above these formations just mentioned, in the Carboniferous formation of both Europe and North America, anthracite occurs in metamorphosed strata. In Wales, Belgium, the Alps and France, such phenomena are frequent. The coal deposits of Massachusetts and Rhode Island are enclosed in highly metamorphosed strata. Much of the material is more nearly graphite than coal. Both the coal and the enclosing strata are so distorted that the bedding is destroyed and the material appears in segregated masses.

In the trap dykes that have penetrated the sedimentary formations of the Connecticut valley and New Jersey, veins of carbonaceous matter occur. These dykes are intruded masses, no doubt formed by the igneo-aqueous fusion of sediments that contained organic remains.[1]

10. With the exception of the exudation of mineral pitch mentioned above, I have seen no notice that bitumen occurs in crystalline rocks, but always in rocks adjacent to or above them. There are vast areas of the palæozoic formations of North America that are not crystalline, that have been more or less subjected to the action of steam and pressure at temperatures that have made them more or less the subjects of metamorphic action. Some of these rocks contain bitumen and others do not. The limestones in the bluffs of the Mississippi river at Minneapolis and St. Paul contain in the cavities of their fossils crystals of pyrite and rhomb spar. They immediately overlie the St. Peter sandstone and are said to belong to the Trenton group. Similar limestones in southern Michigan contain bitumen, free sulphur and sulphates in large amount. In southern Kentucky and Tennessee the limestones are often coarsely crystalline and contain large encrinite stems that are silicified. These same rocks contain geodes lined with crystals of quartz. Other geodes contain sulphates of barium, strontium and calcium, both with and without bitumen. In other localities the rocks of this age are filled with bitumen widely disseminated in small quantities. These rocks often exhibit very slight evidence of the effects of heat, but frequently are found immediately above or upon crystalline schists.[2]

[1] L. C. Beck, *Am. Jour. Sci.* (1), xlv, 335. I. C. Russell, *ibid.* (3), xvi, 112.

[2] S. F. Peckham, *Reports of the Tenth Census of the United States*, Vol. x, "Petroleum," p. 63.

11. In Prof. James Hall's celebrated Introduction to *The Palæontology of New York*, he shows that the earliest palæozoic sediments were deposited in a current that moved from southeast to northwest. Later the current moved diagonally across them from northeast to southwest. These later currents represent a vast interval of time, during which material accumulated to a depth of tens of thousands of feet of coarse sediments to the northeast in Canada, and growing finer diminished to the southwest in the Mississippi valley to a few thousands of feet. If metamorphic action is due to the accumulation of sediments, whereby the isothermal lines of the earth's crust rise to meet the increased pressure, by consequence of which sediments are brought into a state of igneo-aqueous fusion, it is not difficult to explain why, at a period in the earth's history, when the condition of the earth's crust, the ocean and the atmosphere, all contributed to maintain a high temperature, the strata as we pass from the southwest in the Mississippi valley towards the northeast should present, at the surface, increasingly the effects of heat.[1]

12. Let us now turn to Technology and see what the experience of more than half a century can teach us in relation to this question of the origin of Bitumen. Soon after 1830, Reichenbach in Germany,[2] Sèlligue in France and Gregory in Scotland, all worked upon the destructive distillation of pyroschists, wood, coal, peat and petroleum. They all discovered paraffine, and what is suggestive, they all propounded the idea that bitumens are distillates. They established the fact that pyroschists, wood, coal, etc., when destructively distilled yield paraffine and the oils found in petroleum. Sèlligue established quite a valuable industry in France, using as his raw material the schists of Autun. About 1850, the Scotch paraffine-oil industry arose. The raw material was a shale, called Boghead mineral, that was well known to contain fossil fishes. The distillate of this mineral closely resembled petroleum, and when petroleum was discovered in the United States in commercial quantities, the refineries on the Atlantic coast, that had been importing the Boghead mineral, commenced to work petroleum with slight changes in their processes. At the same time, the

[1] *Nat. Hist. of N. Y.*, "Palæontology," iii, 45–60.

[2] *Jour. für Chem. u. Phys.*, von Schweiger-Seidel, 1830, lix, 436. *Trans. Roy. Soc. of Edinb.*, xiii, 124. *Rep. of Pat. Inven.*, n. s., iv, 109. *Jour. des Connaisances Usuelle*, Dec., 1834, p. 285. Dingler, lvi, 40.

Albertite of New Brunswick was also being distilled on the Atlantic coast, while west of the Alleghenies cannel coal was being distilled at Cannelton, on the Kanawha river, in West Virginia; at Cloverport, on the Ohio river, in Kentucky; at Newark, O., and near Pittsburgh, Pa. The experiment of distilling oil from Devonian pyroschists was also made at Erie, Pa. They yielded fifty gallons of distillate to the ton. Without exception every one of these materials yielded paraffine, and when the petroleum obtained from Pennsylvania and West Virginia was used as a substitute, it was found that it yielded identical products, and the coal-oil industry was quickly rendered unprofitable. In an attempt to utilize all available material, William Atwood, who was one of the most skillful technologists in coal oil, was sent to the Island of Trinidad, where a plant was constructed and an unsuccessful attempt made to prepare illuminating and lubricating oils from Trinidad pitch. The pitch furnished distillates very different from the paraffine products obtained in the United States.

During the last years, before the coal-oil industry ceased to be profitable, a number of patents were granted for improvements in this technology, mainly for improved methods of distillation. The aim of these inventions was to effect a uniform heating of the material by which a slow distillation at low temperatures would be promoted. The presence of steam, often superheated, was found to be at all times beneficial. While to produce gas from these materials, it was found necessary to thrust them into a retort heated to a high temperature; to produce oil, it was found on the contrary best to distill at the lowest temperature possible. The intermediate oils, too dense for illumination and too light for lubrication, accumulated in the refineries, until Joshua Merrill discovered that by distilling them in such a manner that the vapors were superheated the vapors were "cracked" or "dissociated," and when they were condensed they were found to be of such a specific gravity that they could be used for illumination. This was the most important discovery ever made in the technology of bitumens, and when applied to the manufacture of paraffine petroleums it was of enormous value.

Soon after 1860, attempts were made to treat the bitumens of southern California by the same methods of distillation that were employed in treating paraffine oils, but all the results obtained showed that the processes were being applied to different materials

and the results were different. These results all pointed to an excess of carbon and more unstable compounds. On analysis these crude oils were found to contain a large percentage of nitrogen as compared with paraffine petroleums.[1]

Canadian petroleum had been known to contain sulphur and to be difficult to refine. When similar oils were obtained in large quantities about 1885, in western Ohio, the sulphur petroleums became a serious problem in the technology of bitumen, as it was commercially desirable to treat them in the same manner as the pure paraffine petroleums of Pennsylvania. During 1893 and 1894, the technology of California bitumens was again investigated. Destructive distillation when applied to these bitumens, resulted in the production of a large volume of gas and asphaltic residuums with a distillate consisting principally of unsaturated hydrocarbons. The crude oils were found to be allied to the crude oils produced in the Scotch shale-oil industry, as they contain a large percentage of nitrogenous basic oils.[2]

There were thus established among North American bitumens three great classes: those known as "Pennsylvania oils," consisting of nearly pure paraffines, for which I have elsewhere proposed the name of Warrenite; those known as "Lima oil," which together with the Canadian oils contain a notable proportion of sulphur compounds, for which I have proposed the name of Maberyite, and the California oils, which occur in great variety and, while containing sulphur, are characterized as nitrogen bitumens and for which I have proposed the name of Venturäite. There is also a class of bitumens not yet investigated that are found on the eastern slope of the Rocky mountains from Mexico to the Arctic circle. In Europe, the paraffine petroleums of Galicia appear to be quite distinct from the bitumens of the Caspian sea. Technology has also divided bitumens into two great classes that are largely determined by geological occurrence. The great petroleum region of North America, which is by far the most important in the world, lies in the great palæozoic basin that surrounds the Cincinnati anticlinal; while the bitumens of California, the West Indies and Europe issue from Tertiary rocks. These Tertiary bitumens are found in much greater

[1] S. F. Peckham, *Reports Geol. Surv., California*, "Geology," ii, Appendix, p. 73.

[2] S. F. Peckham, *Am. Jour. Sci.* (3), xlviii, 250.

variety and are uniformly more difficult to refine into commercial articles than the bitumens obtained from older formations.[1]

It is proper to mention in this connection three classes of investigations that have been made on a commercial scale. The first was made about 1860–65, by Cyrus M. Warren, and consisted in distilling destructively the lime soap made from menhaden (fish) oil. The products of this distillation were refined into illuminating oil, in all respects identical with coal oil and refined petroleum; and they were also proved by an elaborate research to contain the same constituent hydrocarbons. Quite recently, Prof. Karl Engler, has repeated these experiments with the addition of pressure and steam during distillation. Warren's results were confirmed. Still more recently, Dr. S. P. Sadtler has discovered that the vapors escaping from linseed oil while being boiled furnish, when condensed, a petroleum-like liquid, which upon examination was found to consist of hydrocarbons identical with those found in Pennsylvania petroleum. It is an honor to American science that these results, valuable and interesting alike to science and technology, were obtained by American investigators.[2]

The general conclusion from technology appears to be, that for commercial purposes, crude bitumens and the products of their distillation may be duplicated by products of the destructive distillation of pyroschists, wood, coal, peat and a great variety of animal and vegetable substances.

13. It would be entirely unnecessary for my present purpose to notice in detail all the researches that have been undertaken upon bitumen, in all its various forms, since de Saussure published his paper on the *Naphtha of Amiano*, in 1817. It is sufficient to indicate along what lines the investigations have proceeded and in what manner the results have been interpreted. The earliest investiga-

[1] Boverton Redwood, *Petroleum*, etc., London, Charles Griffin & Co., 1896, ii. S. F. Peckham, PROC. AM. PHIL. SOC., x, 445. *Repts. 10th Census, U.S.*, x. "Petroleum," *Am. Jour. Sci.* (3), xlviii, 250 and 389, l, 33. *Science* xxiii, 74. *Jour Frank. Institute*, Nov., 1895. S. P. Sadtler, *Am. Jour. Pharm.*, Sept., 1896. C. F. Mabery, *Jour. Frank. Institute*, cxxxix, 401. *Proc. Am. Acad.*, n. s., xxiii. *Am. Chem. Jour.*, xix, 243, 374, 419, 796. B. Silliman, Jr., *Am. Jour. Sci.* (ii), (xliii,) 242. *Chem. News*, xvii, 257. *Bul. Soc. Chem. de Paris*, 1868, p. 77.

[2] C. M. Warren and F. H. Storer, *Mem. Am. Acad.*, n. s., ix, 177. Karl Engler, *Berichte der Deut. Chem. Gesellschaft*, 1888, xxi, 1816, xxii, 592. Dingler, *Poly. Jour.*, 1889, p. 271. S. P. Sadtler, *Am. Jour. Phar.*, Sept., 1896.

tors analyzed bitumens as if they were homogeneous substances. They determined the carbon and hydrogen, added the percentages together and subtracted the sum from one hundred, calling the deficit oxygen. This went on for nearly fifty years. It is true that Prof. B. Silliman, Jr., fractionated petroleum by distillation, and queried whether the liquids that he obtained were educts or products. It was not until 1863 that Schorlemmer, in England, and Pèlouze and Cahours, in France, published researches that professedly separated the compounds that were mixed together in petroleum. They were soon followed by Warren and Storer in the United States, who, by a superior method of condensation, succeeded in separating the hydrocarbons in coal-tar naphtha, naphtha from Pennsylvania and Rangoon petroleum, naphtha from lime soap of menhaden oil and also the hydrocarbons from oil of cumin. These researches established the existence in these liquids of several series of hydrocarbons, the members of which were identical, whether obtained from natural or artificial substances, and were also in many cases recognized as identical with chemical compounds already well known.[1]

Since these results were published, a great amount of work has been done with varying success upon a great variety of petroleums, in which work progress has been observed along two lines, viz., first, better methods of separation, and second, better methods of ultimate analysis. It is only quite lately, however, that Prof. C. F. Mabery has succeeded, by distilling *in vacuo* with Warren's hot condenser, in so completely avoiding decomposition by cracking as to reach results that are final. While this is said without any wish to disparage the work of other investigators, it must be said with a proper regard for truth.[2] There is, however, a vast amount of chemical research on record, a very complete *résumé* of which can

[1] Theo. de Saussure, *Ann. Chim. et de Phys.* (2), iv, 314–320. *London Jour. of Sci.*, iii, 411. B. Silliman, Jr., *Am. Chemist*, ii, 18. *Moniteur Scientifique*, No. 366. *Am. Jour. of Gas Lighting*, xvi, 83. Wagner's *Ber.*, 1872, p. 848. C. Shorlemmer, *Chem. News*, 1863, viii, 157; xi, 255. *Am. Jour. Sci.* (2), xxxvi, 115. *Rep. de Chim. Appliquée*, 1863, p. 174. *Jour. für Phar.*, xxi, 320. J. Pelouze and Aug. Cahours, *Comptes Rendus*, lvi, 505; lvii, 62. *Ann. de Chim. et de Phys.* (4), i, 5. *Am. Jour. Sci.* (2), xxxvi, 412. C. M. Warren and F. H. Storer, *Mem. Am. Acad.*, n. s., ix, 121–176. *Am. Jour. Sci.* (2), xxxix, xl and xli. *Chem. News*, xii, 85, 261, *et seq.*

[2] C. F. Mabery, *Proc. Amer. Acad.*, n. s., xxiv; *Amer. Chem. Jour.* xix, 243, 374, 419.

be found in the exhaustive work of Mr. Boverton Redwood, which has given results sufficiently accurate for my purpose. These results may be generalized as follows :

The Pennsylvania petroleums are the purest paraffine petroleums known. They contain small percentages of olefines and traces of benzoles. The same hydrocarbons have been found in other petroleums, in the distillates from cannel coal, pyroschists, peat, wood tar, fish-oil soap, fish oil under pressure and linseed oil, and also from grahamite, albertite, ozocerite and many other substances of mineral and organic origin.[1]

The Lima and Canadian petroleums contain the paraffine series, with a notable proportion of sulphur derivatives of the paraffines, formed by substitution ; and also traces of benzoles and nitrogenous basic oils.[2]

The Russian oils contain the benzole hydrides and naphthenes.[3]

The California oils, so far as at present known, consist of the benzole hydrides, naphthenes, benzoles and sulphur substitution compounds with a large percentage of esters of nitrogenous basic oils.[4]

The Scotch shale oils contain paraffines, olefines, benzoles and esters of nitrogenous basic oils.[5]

These esters are also found in coal tar and in Dippel's oil, the latter being an oil obtained as a distillate from the gelatine of bones.

No satisfactory research has ever been undertaken upon semi-fluid malthas or solid asphaltums. They cannot be distilled without decomposition, and no analysis by solution has yet been made that was not highly empirical. It is assumed, rather than proved, that many solid bitumens contain oxygen. They certainly do contain sulphur, and in some instances they contain nitrogen. When distilled upon the large scale solid bitumens are decomposed and

[1] Schorlemmer, Pelouze et Cabours, Warren and Storer, Mabery, *loc. cit.*

[2] Mabery and Smith, *Proc. Amer. Acad.*, n. s., xxiii ; *Amer. Chem. Jour.*, xvi, 83, 89, 544; xvii, 713; xix, 419.

[3] Beilstein and Kurbatow, *Ber. d. D. Chem. Ges.*, 1880, p. 1818. *Jour. Amer. Chem. Soc.*, xiii, 232. Markonikow and Oglobini, *Ber. d. D. Chem. Ges.*, xviii, 2234 ; *Ann. de Chim. et de Phys.* (6), ii, 372.

[4] S. F. Peckham, PROC. AMER. PHIL. SOC., x, 445 ; xxxvi, 154; *Amer. Jour. Sci.* (3) xlviii, 250. C. F. Mabery, *Jour. Frank. Inst.*, cxxxix, 401. Boverton Redwood, *Petroleum*, i, 203.

[5] English patents.

nothing but decomposition products are found in the distillate, while coke remains in the still. These decomposition products are very varied. Those that are geologically old yield paraffine, while those that are recent do not.[1]

Prof. Mabery has remarked that all petroleums contain the same proximate principles in different proportion. While this statement may be absolutely true, it is not so relatively. The palæozoic bitumens have been most carefully studied and they consist mainly of paraffines. The Tertiary bitumens have been less carefully studied, and they consist principally of benzoles and their derivatives in great variety. Mingled with these are the olefines and other series of hydrocarbons in small proportion, with an immense number of oxygen, sulphur and nitrogen derivatives and substitution compounds, the existence of which has been only recently suspected.

It can, therefore, be asserted that the natural bitumens and the substances resembling them that are obtained by the destructive distillation of mineral and organic substances, are strikingly similar. The palæozoic bitumens bear a resemblance to the simple distillates produced in the presence of steam, at low temperatures, when nitrogen is practically absent. The Tertiary bitumens resemble the distillates obtained at higher temperatures and when the raw material is rich in animal remains. There are, however, a large number of bitumens that have been too little investigated to admit of any generalizations concerning them. In illustration of this statement I would call attention to the valuable papers of Prof. Henry Wurtz, in which he shows that many so-called native paraffines are probably olefines.[2] I would suggest that some of them may be the higher naphtenes, that have the same percentage composition as olefines. The solution of these problems awaits a vast amount of research.

14. In the preceding pages I have given an outline of the views generally held by chemical and physical geologists concerning the chemical phenomena attending the cooling of the earth and its shrinking and contracting crust. To these I have added a *résumé* of the technical and chemical knowlege we possess concerning bitumens. I shall now proceed to discuss, in the light of these facts,

[1] S. F. Peckham and L. A. Linton, *Amer. Jour. Sci.* (4), i, 193. S. F. and H. E. Peckham, *Jour. Soc. Chem. Industry*, xvi, 424; H. Endemann, *ibid.* xv, 871; xvi, 121.

[2] H. Wurtz, *Eng. and Min. Jour.*, xlviii, 25, 114; li, 326, 376.

the occurrence of bitumens and the relation of such occurrence to their probable origin.

Leaving the problems of orography to the physical geologist for solution, there are a few suggestions to be made relating to these problems that I have not seen anywhere mentioned. If we regard the dizzy heights of the Andes and Himalayas, or the profound abysmal depths of the Pacific as isolated phenomena, they appear on a scale of oppressive grandeur and immensity; yet these irregularities in the earth's crust reach a maximum of only about ten miles in vertical height, which is only one twenty-five hundredth or four hundredths per cent. of the circumference of the earth at the equator. The local foldings of a few hundreds of feet in disturbed strata are microscopic when compared with the earth's diameter; and yet we are accustomed to regard these plications of strata as the result of sudden movements in the earth's crust. This is a pure assumption. The period of time through which critical observations of geological phenomena have been made when compared with the time that has elapsed since life dawned upon the earth is also microscopic; it is a smaller fraction than four hundredths per cent. The element of time in geological phenomena is only just beginning to be appreciated. We have learned from a few years of observation that some continental masses are rising and others falling with reference to the sea level; yet no one has observed these movements through many centuries, nor have these vertical movements of the coasts of the world been correlated and the laws that govern such movements been determined. We do not know whether a continent has emerged from an ocean maintaining a constant level, or whether the ocean has receded as the contracting mass has rendered the ocean depths more profound, or, as is more probable, the shrinking of the crust has changed the distance of the ocean surface from the centre of the earth, rendering the elevations apparently greater. It is not material to this question that we should know. Nor is it of importance to consider whether the continued operation of forces at present active through countless centuries, or the repeated interjection of cataclysms of world disaster, has brought the earth to its present condition. Volcanic eruptions, earthquakes and floods, separately and unitedly, change the face of nature within our own generation; it is reasonable to suppose that they have acted from the earliest period of the earth's history to the present time with constantly lessening vio-

lence. It is true that the local effects of such phenomena as the earthquakes at Lisbon and Java and the Red River fault appear cataclysmic; yet these effects are microscopic when compared with the dimensions of the earth, and may have been, nay, probably were the culmination of a series of movements that had been in progress for immense intervals of time. I therefore believe that in stating the causes of those changes that have taken place at the surface of the earth as we now know it, one of the most important considerations is the unlimited periods of time through which the pressure due to accumulation of sediments and the consequent development of heat has acted upon those sediments, which in many instances were filled with water charged with mineral matter in solution. From the combined action of pressure, heat and steam, through unlimited periods of time, the constituent elements of sediments have been brought into every possible state of combination, from obsidian and pumice, which have been completely fused, through lavas, granites, gneisses, etc., to sediments in which there has been no change at all. As Dr. Hunt has fully shown, the action of thermal waters, which have been largely instrumental in producing these changes, has been often extremely localized both laterally and vertically, and may be greatly varied by the constituents of the sediments themselves.

15. If, then, we accept the hypothesis that all of the rocks as we now know them are sediments, whatever may be their present condition, we are forced to the conclusion that life first appeared upon the planet at a date too remote to be determined even in geologic time, and that the remains of organic forms have practically been a constant constituent of sediments from that time to the present. As might be expected, we find organic remains in every possible condition, from crystallized graphite to unaltered cellulose. Vegetable and animal remains are found in every conceivable condition of replacement and alteration. We find pseudomorphism in the strictest sense as well as metamorphic action developed in every possible degree. Nor can we assert that any of the older strata are free from such action, for metamorphism is, as the word signifies, a change of form, and no limits can be assigned to such change in either time, place or degree that are not arbitrary. There can be no question that as sediments have accumulated slowly so these changes have progressed slowly.

Nevertheless, following upon long periods of quiet, there appear to have been periods of cataclysmic violence, as when the vast lava

sheets that form the table mountain of the Sierra Nevada were poured out, not from a single peak, but from a whole range of peaks; when the whole of southern Colorado and northern New Mexico and Arizona were covered with lava sheets thousands of square miles in extent; or when the valleys of West Virginia were upheaved, the Oil Break formed and the mass of plastic grahamite forced into the fracture; or when the basic rocks that form the mounds of iron porphyry in Cumberland and Foster, R. I., were thrust up from the deeps; and the trap dykes along the whole eastern borders of the Alleghanies were poured into fractures of local extent. But these convulsions that have brought basic porphyrys, basalts, trap dykes and local metamorphism to the surface, have in the physical and chemical operations of nature produced anthracites and anthracitic residues and not bitumens. Bitumens are not the product of the violence of volcanic or cataclysmic action, but of the gentler action of normal metamorphism exerted through long periods, during which the volatile bitumen has been distilled from sediments containing organic matter, and at the lowest possible temperature, without regard to time, as the sediments were pressed down to an isothermal that admitted first of their distillation and then of the conversion of the carbon residues into graphite.

16. Dr. Hunt has left hundreds of pages in which he has shown that the crystalline and eruptive rocks, as we know them, are altered sediments. His argument is conclusive that the carbon that they contain is derived from organic forms. When discussing bitumens he shows, first, that the pyroschists do not, except in rare instances, contain bitumen, and are not in the proper sense of the word bituminous. Secondly, he shows that the pyroschists do not, "whether exposed at the surface or brought up by boring from depths of many hundred feet, present any evidence of having been submitted to the temperature required for the generation of volatile hydrocarbons." Thirdly, he shows that as the oil occurs in the limestone it could not have been distilled. He further shows that the Utica slate that is beneath the lower Devonian limestones is unaltered, and adds, "More than this, the Trenton limestone, which on Lake Huron and elsewhere has yielded considerable quantities of petroleum, has no pyroschists beneath it, but on Lake Huron rests on ancient crystalline rock with the intervention only of a sandstone devoid of organic or carbonaceous matter.[1]

[1] T. S. Hunt, *Essays*, p. 169, ed. 1875.

I have already shown (§ 6) that sediments become crystalline at very low temperatures and that the crytalline schists below the lowest stratified rocks contain abundant evidences of organic forms. Are we to suppose that there was no intermediate zone in which normal metamorphism died out and faded into unaltered sediments? We ought to expect to find the pyroschists in their normal condition. We ought to expect to find the coal altered or unaltered, according to its proximity to the heated area. We should not expect to find the carbonized remains of organic forms in rocks containing bitumen; for we cannot suppose that those beds that yielded the bitumen by distillation were suddenly plunged into a condition of igneo-aqueous fusion by which the organic constituents were instantly converted into anthracite and gas. As a general rule the process of conversion must have been as gradual as the progress of deposition. We cannot assume that in every instance the anthracite is the residue from a distillation of which the distillate was completely lost. Moreover, the example cited in § 7 is a complete demonstration, occurring as it does in a region rich in bitumen, that the change from sediments to crystalline schists is progressive and involves the organic as well as mineral constituents of the strata.

17. If a traveler should leave Boston, Mass., and travel in a generally southwest direction toward San Diego, in southern California, he would encounter along his route a series of object lessons that would lead to but one conclusion. Whatever the age of the crystalline rocks of New England may be, they are certainly for the most part older than the Carboniferous. The small basin around Mansfield, Mass., extending into Rhode Island, which contains the anthracites of that region, is surrounded by crystalline rocks, and, indeed, the anthracite beds themselves are, as already stated, altered to a substance nearer graphite than coal. The coal slates contain only impressions of coal plants, and fossils of any description are extremely rare in the vicinity. Intrusions of trap are frequent, and cones of highly basic porphyrys are thrust up through all of the crystalline sediments at several points. The change of form has been very complete in respect to every constituent of the sediments.

Westward around New Haven, Conn., the bedding of the sediments has not been so completely obliterated, but the change in the organic constituents has been quite as general. In the gneissoid

traps of that region, thin veins occur of anthracitic material, which alone remains to represent the organic constituents of the altered sediments. Continuing our course southwestward the same changed condition is observed in the crystalline schists of Manhattan Island, and across the Hudson through northern New Jersey. Intrusions of trap, too, are frequent through all this region and the sole representative of the organic constituents of the sediments is anthracitic residues.

On the western slope of the Catskills, through eastern New York, the crystalline rocks which exist at varying depths below the surface are overlaid with sediments which are frequently imperfectly metamorphosed, and as one moves westward into central New York and northeastern Pennsylvania, while the coal beneath the surface is anthracite and the residues before mentioned that fill cavities in the limestone are anthracitic, still the surface rocks show less and less signs of alteration. As the summit of the Alleghanies is reached and passed, the coal beds fade by insensible stages from anthracite into unaltered splint and cannel coals. The beds of slate also become beds of pyroschists, and the formations generally assume the aspect of unaltered sediments. On the western slope of the Alleghanies the surface descends much less abruptly than it ascends on the eastern slope. The dip of the formations is much greater than that of the surface, consequently the outcropping edges of newer formations are repeatedly encountered, until in western Pennsylvania and New York metamorphism has ceased to be a problem in surface geology. These surface rocks are, however, geologically all below the coal, which in eastern Pennsylvania is metamorphosed into anthracite. There is no arbitrary line that separates the unaltered from the altered strata. The successive formations have thinned out, and in general they continue to become thinner as we go southwest; but there is no anthracite between the crest of the Alleghanies and the mountains of Arkansas. Throughout the Mississippi valley, as we pass to the west, these formations outcrop and overlie each other precisely like the shingles on a roof, with the pitch reversed.

In the Bradford oil field, in McKean county, Pa., the drill penetrates a bed of porous sandstone that lies enclosed in impervious unaltered strata. It contains a few shells and fish bones, but no other fossils. Like the surface rocks it lies sloping toward the southwest, the lower portion submerged in salt water, the middle

portion filled with petroleum and the upper portion filled with gas; both originally under an enormous pressure. In Warren county, farther to the southwest, the drill reaches petroleum not in the McKean county sand, but in a different sand, higher in the series. Still farther southwest, in Venango county, the surface rocks are still higher in the series and the drill reaches petroleum in a pebble conglomerate that outcrops at the surface to the northeast. These pebble conglomerates, known as the "Venango Oil Sands," formed great riffles in the currents of the primeval ocean. They are several miles long and a few rods wide, level on the upper surface, and rounded on the under surface to a feather edge at the sides. One is above the other and they are covered, when they contain petroleum, with a solid, impervious shell of silica, that the drill penetrates with difficulty. The uppermost of these conglomerates consists of spherical pebbles of yellow quartz, about as large as cranberries; the lowest consists of lenticular pebbles of very white quartz. In both cases the pebbles are cemented together at their points of contact leaving large open spaces. These conglomerates are sometimes replaced by coarse, porous sandstones; neither of these contain fossils of any kind. Still farther southwest, on Slippery Rock creek in Mercer county, and at Smith's Ferry in Beaver county, another sandstone, that is barren where it occurs in Venango county, yields petroleum above the pebble conglomerate. If a line be followed farther to the left, across western Pennsylvania and into West Virginia, the outcrops of the formations would rise successively in the scale until the oil would be found in the Mahoning sandstone, which lies at the top of the Lower Productive Coal Measures. Since the development of the Lima oil fields the range of rocks holding the petroleum reaches in Ohio, Canada and Pennsylvania from the Lower Silurian, Trenton limestone, to the Lower Coal Measures. These rocks embrace nearly the entire palæozoic formations of North America. Very few wells have been sunk below the petroleum-bearing sandstone, for the obvious reason that it involved a useless expense. One of the deepest wells ever drilled in the oil region of western Pennsylvania was Jonathan Watson's deep well near Titusville. This well went down through all of the oil sands and the Devonian shales beneath them, to a depth of 3553 feet, when just as it was abandoned a hard rock was struck which was supposed to be the Corniferous limestone, which is the oil-bearing rock of Canada. The interval between the oil sands and the bottom of the

well was filled with Devonian shales, that underlie the Bradford oil sand and are supposed to extend from Allegheny county, New York, to central Kentucky; and in fact to underlie the entire petroleum region that produces Warranite—the pure paraffine petroleums. When "dry" or unproductive holes are drilled outside the productive areas, they pass, at the horizon of the oil sands, through a different rock, which is compact and incapable of holding petroleum. These underlying Devonian shales outcrop at Erie, Pa., and furnish there the material that on distillation yielded fifty gallons of distillate to the ton. Where this formation outcrops it is filled with fucoids and has yielded small petroleum and gas wells. The men who drilled Jonathan Watson's deep well told me that, "the soap stone (Devonian shale) became harder as they went down, and was redder in color, in fact, had been burnt like brick." In a comparatively few localities, petroleum has been found saturating rocks that lie one above the other. The upper rock invariably yields the most dense oil. In 1881 I saw a well in West Virginia, from which the same walking beam pumped at every stroke oil of 27 degrees from a depth of 255 feet and oil of 45 degrees from a depth of 600 to 700 feet.

18. I have never seen a specimen of graphite reported to have come from any locality between the crest of the Alleghanies and the Ozark uplift. This is an uplift of the palæozoic formation west of the Mississippi river, extending from central Missouri to central Texas. It resembles that of the Alleghanies, but is on a smaller scale.[1] The eastern slope is more abrupt than the western. The formations of the central portions, in Arkansas and the Indian Territory, are highly crystalline, graphite and anthracite are of frequent occurrence and are found on the western slope. On this slope also, but farther west, in unaltered strata immediately above the crystalline formations, bitumen occurs in enormous quantity and great variety. Over a large area in the northeastern portion of the Indian Territory heavy petroleums are found only a short distance beneath the surface, and, as I am informed, below the coal. South of the Red river, in northern Texas, bitumens occur saturating horizontal beds of sand that are intercalated between strata of more or less solid limestone. North of the Red river, in the Indian Territory, every rock formation that is at all porous appears to be

[1] J. C. Branner, "Former Extension of the Appalachians across Mississippi, Louisiana and Texas," *Am. Jour. Sci.* (4) iv, 357.

filled with bitumen. As far as I have investigated it, the bitumen is uniform in kind and quality. It has saturated beds of sand, strata of sandstone and limestone, some of which are hard and crystalline, others magnesian and almost as soft as chalk, some of them without fossils and some almost all fossils, and all of them conformable with the Upper Silurian and Lower Carboniferous rocks that enclose them. In one locality a sort of bituminous breccia occurs, of immense extent, consisting of fragments of limestone and quartzite cemented together with bitumen. In another an immense horizontal bed of sand, completely saturated with bitumen, is overlaid with thirty or forty feet of conglomerate that has been more or less penetrated with it.

Almost all the beds north of the river are in very sharp folds, that bring the strata to the surface nearly vertical, in eroded anticlinals that extend across the country in parallel lines, often many miles in length. What is of especial interest in this connection is the occurrence in the vertical limestones and sandstones of imperfectly saturated strata. The bedding varies from the thickness of paper to a few inches. The rock mass was usually most easily penetrated along the lines of the thinnest beds. Fractures which cross all these beds, including both the thin and thick ones, show the bitumen completely filling the thin beds and only partially penetrating the seams and the mass of the thicker cryptocrystalline strata. Nothing could more beautifully and clearly demonstrate the fact that the bitumen was not indigenous to these rocks, but had penetrated them while previously and as at present in their nearly vertical position.

19. Continuing our journey across the continent, bitumen is frequently encountered in positions contiguous to normal or local metamorphism, until we descend into the great valley of California, west of the Sierra Nevadas. Here the development of bitumen has proceeded on a scale of vast magnitude. On the western slope of the Sierras the region around Roseville, in Placer county, and the vicinity of the city of Stockton, are well known to be rich in natural gas.[1] There are localities on these slopes that have also furnished limited supplies of petroleum, but, as before stated, the bitumen deposits of California are principally found in the Coast Ranges, including the ocean area lying between the Santa Barbara

[1] W. L. Watts, *The Gas and Petroleum Formations of the Central Valley of California*, 1894.

islands and the main land. The richest deposits have been found in Ventura county, on the border line that separates the Cretaceous from the Lower Miocene. None of the bitumen is found in crystalline rocks; yet the evidences of both normal and local metamorphism, in strata not far distant from the bitumen-bearing rocks, are abundant. The late Eli W. Blake once visited the Santa Barbara islands and afterwards described to me the cascades of lava that had descended from the volcanic cones in the centre of the islands over precipices into the sea. Bitumen has exuded for more than a century from the unaltered strata, whose upturned edges form the bed of the ocean, between these islands and the main land. The Tertiary formations that constitute the bluffs of the coast east and west of Santa Barbara contain deposits of bitumen of enormous extent and exhibit evidences of metamorphic action still in progress. Almost every large bluff from Point Conception to San Diego contains a solfatera, the action of which leaves the Miocene shales, originally rich in organic matter, devoid of a trace of carbon.

The best petroleum wells of Ventura county lie in the cañons of the Sulphur mountain, one of the foothills of the Coast Ranges. Other wells are similarly located with reference to these ranges.[1] None of them have penetrated crystalline rocks; yet the core of the Coast Ranges only a few miles east of the wells of the Pacific Coast Oil Co., as Dr. Goodale and myself found, is granite. Fragments of crystalline rocks are washed out of many of the large cañons that head in the main Coast Range back of the foothills in which the oil wells are drilled. Deep drilling is extremely difficult in this region on account of the fragile character of the rocks. It might be impossible to carry a well down through all the bituminous strata to the crystalline rocks, but the fact that they are altered Miocene sediments and exist at a comparatively short distance below the surface does not admit of any question. The evidences of metamorphism, through the agency of hot, silicated water, are found everywhere. The formations contain abundant remains of highly organized animals; and the bitumens which they contain consist of benzoles and naphthenes, without an "appreciable amount of paraffines, if any."[2] They also contain sulphur and nitrogen. They are evidently

[1] S. F. Peckham, *Mineral Resources of the United States*, "Petroleum in California," 1894.

[2] Letter of C. F. Mabery to S. F. P.

the products of the distillation of highly organized animal tissue, as an effect of the accumulation of sediments, and of metamorphic action upon unaltered sediments, through granite and gneiss to lava and pumice.

20. If we turn from North America to Europe-Asia, the testimony of the most eminent observers seems equally convincing. Daubrée was satisfied that the origin of the bitumen was found in metamorphism. Other French chemical geologists were equally well-grounded in this belief. As early as 1835, M. Rozet read a paper before the Société Geologique de France in which he discussed the occurrence of asphaltic limestone at Pyrimont. He says, "The bituminous matter is found equally in the calcareous rock and the molass that covers it. It is evident the action that introduced it into the two rocks is posterior to the deposition of the latter. The manner in which it is distributed in great masses, which throw their ramifications in all directions, joined in such a manner that the superior portions generally contain less bitumen than the remainder of the mass, indicate that the bitumen has been sublimed from the depths of the globe. . . . . It may be objected that such basaltic rocks do not appear in all the extent of the Jura. To that I reply that they are found in the neighborhood, in Burgundy and in the Vosges and further, that in the changes in the surface of the soil, whether occasioned by fractures or by the disengagement of vapors, the plutonic rocks do not necessarily appear at the surface. Perhaps in the deep valleys of the Jura the basalts are of very slight depth. . . . . In the Val de Travers, near Neufchatel, similar phenomena are observed."[1]

In 1846, Mr. S. W. Pratt associated the occurrence of bitumen at Bastennes with the eruption of ophite in the Pyrenees.[2] In 1854, M. Parran remarks concerning the occurrence of bitumen in the environs of Alais, "whatever be the origin of these substances, whether they be due to interior emanations from fissures of dislocation or to circumstances exterior and atmospheric, it is evident that there was during the Tertiary period an asphaltic epoch in relation to which it is convenient to recall the numerous eruptions of trachytes and basalts which characterize that period, and have probably acted by distillation upon masses of combustibles hidden in

[1] *Bull. Geol. Soc. de France* (1), vii, 138.

[2] *Quar. Jour. Geol. Soc.*, ii, 80.

the bosom of the earth."[1] The anthracites of the Alps offer convincing proof that large amounts of organic matter have been involved in the metamorphic action that has prevailed in that region. In like manner the relation of the bituminous deposits of Galicia and Roumania to the crystalline rocks of those countries show the part that metamorphism has played in their occurrence.

21. No theory that refers the origin of the bitumen to any physical or chemical action that has prevailed on a cosmic scale can satisfactorily explain the differences that exist in crude bitumens. Mr. Phillips has added the testimony of chemistry itself to show the improbability of a chemical origin for bitumens on a cosmic scale. Dr. Day has shown the reasonableness of an hypothesis which regards the bitumens of Pennsylvania as distillates, but his idea that the variation in the petroleums of that region is due to the effect of filtration is, in my judgment, hardly tenable. In Pennsylvania the darkest and heaviest oils are nearest the surface. The sulphur content of bitumen is too wide a subject to discuss here in detail; yet it may be said in general that sulphur enters bitumens by a secondary reaction between the bitumen and the sulphates dissolved in natural waters. The freedom of Pennsylvania petroleum from sulphur has already been shown to be due to the absence of sulphates in the natural waters of the region in which they occur. As has already been stated, Prof. Mabery has shown that the sulphur compounds found in Lima oil are sulpho-paraffines. This would naturally follow the reduction of sulphates by paraffines, the reaction being a double decomposition in which sulphur is substituted for hydrogen in the paraffine. Filtration would not be likely to remove such compounds from solution in the other constituents of the petroleum.

In his discussion of the "Occurrence of Petroleum in the Cavities of Fossils," Mr. Phillips has offered some ingenious but wholly unnecessary suggestions to account for the presence of a nearly solid bitumen in the cells of a coral reef uncovered in a quarry. Petroleum occurs in the rocks of the oil regions filling cavities of every description. Geodes, fossils, sandstones, pebble conglomerates, porous limestones, the Chicago dolomite, gravel, anything and everything that has a cavity or a pore, has been found saturated with it. Why? Simply because the enormous pressure under which the bitumen has accumulated in the crust of the earth has

[1] *Ann. des Mines* (5), iv, 334.

forced it there. When it has entered cavities like those in the coral reef described by Mr. Phillips, the diminished pressure and evaporation have resulted in the escape of the most volatile constituents. When the reservoir of the Bradford field was first penetrated, the pressure was estimated at 4000 pounds to the square inch. Whether or not this estimate was approximately correct, the pressure was sufficient to throw the well casing and piping out over the top of a derrick and land it in a meadow near by. A short time after the famous Karg well was struck near Findlay, O., I, myself, saw a pressure gauge register 450 pounds per square inch. Burning gas wells in western Pennsylvania sent streams of flame into the air eighty feet in height. Notwithstanding this accumulation of the facts of experience during many years, writers still ignore the tremendous significance of such phenomena, and speak of these deposits of bitumen as if they resembled a turn-over or an apple-dumpling laid away by nature. Gas cannot have been held under such tremendous pressure through cycles of geologic time in reservoirs of porous rocks, from which it has been filtering, as suggested by Mr. Phillips.

The complete inadequacy of all these arguments was never more fully set forth than in the language used by Mr. Phillips: "The movement of the oil through the rock displaced from the interstices in which it had originally collected would have been accelerated as the transition from solid organic tissues to liquid had been advanced." The decomposition of organic matter *in situ* could never have occurred under any conditions of accelerated pressure of even moderate amount. The rocks must have been consolidated and capable of resisting pressure before, action and reaction being equal, the pressure could accumulate. These facts are themselves the strongest reason for belief that the bitumens were never formed *in situ* in the porous rocks that contain them, but were gradually accumulated in those porous rocks that had been previously overlaid with impervious strata capable of resisting the enormous pressure until the reservoirs were penetrated by the drill. The fact that in the limestone some fossil cavities are filled while others are empty lies in the further fact, that the lines of shrinkage and other fractures penetrated some of the fossil cavities while others remained intact.

22. Upon this hypothesis, that bitumens are distillates, all of the variations observed in bitumens of different geological ages are

easily explained. The earliest forms of animal and vegetable life are admitted to have been nearly destitute of nitrogen; hence when these forms accumulated in sediments, which, borne down by deposits above them, invaded an isothermal that admitted of their distillation, they must have been distilled, in the presence of steam, at the lowest possible temperature; they must have been distilled under a gradually increasing pressure, the extent of which depended upon the porosity of the sediments above them, up to the surface. They must also have been distilled under a gradually increasing temperature which would have been largely controlled by the pressure. While the temperature and the pressure would have in every instance been the least possible, with steam always present, these physical conditions would on account of the varying porosity and consequent varying resistance of the overlying mass have produced very great effects in some instances and very slight effects in others. As a consequence, we have in natural bitumens, as in artificial distillates, materials varying in density from natural gas to solid asphaltum.

If these distillates proceeded from materials that would yield paraffine, these permanent and stable compounds, from marsh gas to solid paraffine, remained in the receptacles that nature had provided for them until they were released by the drill. If, however, the distillates proceeded from sediments of a different geological age, containing animal and vegetable remains more highly organized, that would yield different series of hydrocarbons, with compounds of nitrogen, then a very different bitumen would be stored in these receptacles. Secondary reactions would convert these primary distillates into a great variety of substances. The contents of the original reservoirs, borne down and invaded by heat, might become involved in a second distillation at an increased pressure and temperature. Fractures of these reservoirs from excessive pressure might lead their contents to the surface along lines of contact of strata or with water containing sulphates by which an originally pure hydrocarbon would be converted into a sulphur bitumen. A nitro hydrocarbon, reaching the surface under these conditions, might, by the combined action of evaporation and reaction with sulphates, pass through all the varying degrees of density from petroleum to maltha and become finally solid asphaltum, and this through the lapse of time and abundance of material on a scale of vast magnitude.

23. Such, then, is the "Testimony of the Rocks," along a line which spans the western continent. Nearly the whole of this line has been brought under my own personal observation. There is also reason for believing that a line might be followed in the eastern continent from the North sea to Java that would furnish equally convincing proof. To this testimony is added that of chemistry, technology, mineralogy, and the chemistry of the cooling earth. Each supports and corroborates the other. We have no need to search for coke until we know that coke was formed. We have no need to assume, that in the laboratory of Nature high temperatures and rapid action were necessary to produce results, for which infinite periods of time and the lowest possible temperature were fully adequate.

24. Since this paper was written I am in receipt of the annual address of the President of the Geological Society of America—Dr. Edward Orton—read at Montreal, December 28, 1897; from which exhales the exquisite aroma of fine literature, as from all the other productions of its accomplished author.[1] In this address I note two very important observations. He says, in speaking of Mendelejeff's chemical hypothesis, "It is hard, therefore, to see why, the whole world over, petroleum is entirely wanting in the Archean and exclusively confined to the stratified rocks. There is not an oil field in the world in rocks of Archean time." I pass this by without comment to notice his observation upon the gas wells drilled in Oswego and Onondaga counties, N. Y., one of which penetrated a limestone that was found between the Pottsdam sandstone and granite, and furnished a gas pressure of 340 pounds; the other at a depth of 120 feet, in the Trenton limestone, gave the gas pressure of 1525 pounds. Dr. Orton well says, "A rock pressure of 1500 pounds to the square inch stands for, nay demands, a hermetic seal." Speaking of the Pottsdam sandstone and the dark limestone beneath it, he says, "The drillings brought from these horizons seem normal in every respect. Certainly there is no hint of any transformation by heat. 'The smell of fire has not passed on them.' There is no carbon residue. The bituminous products found in them cannot owe their origin to the usual form of destructive distillation." It is not likely, that the usual form of destructive distillation as illustrated in a gas retort has obtained anywhere in the operations of nature. I regard the penetration of granite

[1] *Bull. Geol. Soc. America*, ix, 93.

beneath bitumen-bearing rocks as a most conclusive and unexpected support to the validity of the views that I have herein set forth. I therefore, with this argument, for the present leave the subject.

NOTE.—I have quoted thus fully from Dr. T. Sterry Hunt for two reasons; with all his eccentricities, he was a man of untiring industry and a profound interpreter of the phenomena of nature in the light of experiment. Therefore, no writer of recent years has expressed views that are entitled to more respectful consideration. He is also more widely quoted by both American and European writers upon the subject of the origin of bitumens, especially as an exponent of the doctrine that bitumens are indigenous to the rocks in which they are found, than any other author.

HERPETOLOGICAL NOTES.

BY JOHN VAN DENBURGH.

(*Read April 1, 1898.*)

1. *Bufo boreas in Alaska.*—In the winter of 1896, Mr. A. W. Greeley, a student at Leland Stanford Junior University, gave me for examination two toads which he had "taken swimming in a large lake near Prince William's sound, Alaska, July 15, 1896." These are typical specimens of *Bufo boreas*, distinguishable at a glance from *Bufo halophilus*, and its northern form *B. h. columbiensis*. Unless my memory fails me, no toad has heretofore been recorded as Alaskan, and these specimens are, therefore, of great interest, since they greatly extend to the northward the known range of this family, genus and species upon the Pacific coast.[1] One of these specimens contains eggs which must have been nearly ready for laying.

2. *On the Time of Laying of the Western Gopher Snake in Central California.*—Early in the month of July, 1897, I received a fine, moderately large specimen of the Western Gopher Snake (*Pituophis catenifer*), which had been captured a few days before "in a marsh near Palo Alto," Santa Clara county, Cal. During the next few days this snake lay almost motionless in a small box in my office in the California Academy of Sciences. On the afternoon of

[1] Toads have been reported from Gt. Bear Lake.

July 13, however, it became very restless and seriously injured its snout in attempting to find some hole through which it might escape from its prison. The next morning—July 14—to my surprise, several eggs were in the box, and the number was added to at intervals until by noon of the next day nineteen eggs had been laid.

The eggs when first laid are covered with a loose, soft, sticky, parchment-like white membrane. This quickly dries and hardens, shrinking upon the substance of the egg until quite tense, and cementing each egg to the others upon which it is laid. After the membranous shell has become dry it ceases to shrink, and if the substance of the egg be reduced, as by evaporation, wrinkles appear upon its surface. However, the softness of the shell and its power to shrink upon its contents are restored by the application of water.

The eggs as laid formed a great cluster surrounded by the coiled body of the snake. The latter hissed fiercely when the eggs were removed, although she had not shown the slightest resentment when handled on previous days.

3. *The Breeding of Plethodon oregonensis.*—A female salamander of this species with three eggs was brought to me from Mill Valley, Marin county, Cal., where it had been found April 19, 1896. The gentleman who secured them stated that the salamander and eggs had been found together under a decaying log in the redwood woods. These eggs, like those of *Autodax iecanus*,[1] are very large (6 mm. in diameter) and almost or quite without pigment. They were covered with a thin gelatinous coating which caused them to stick together. In my office they were placed with the salamander and some bits of wood and damp moss in a darkened jar. This situation, however, proved to be unsuited to their development, for the eggs soon became covered with mold. The most interesting fact remains to be told. As soon as placed in the jar the salamander took charge of the eggs, lying beside them and holding them in a loop of its tail. Evidently dissatisfied with their position and surroundings, the Plethodon moved the eggs from place to place in the jar, holding them always in the crook of its tail. This was done several times in the course of three or four days, and the solicitousness of the salamander continued until the eggs were quite moldy. Finally the eggs of the cluster were broken apart and one was eaten by the salamander. Thinking it probable that this sala-

[1] See *Proc. Cal. Acad. Sci.* (2), v, 1895, p. 777.

mander was a male, I examined it with care, but found that it was a female with well-developed ovaries containing ova of various sizes.

4. *The Colors of a Living Specimen of the Lower Californian Boa, Lichanura trivirgata.*—The California Academy of Sciences recently received, through Mr. F. Billa, a fine specimen of the Lower Californian boa, collected near San José del Cabo. This specimen shows beyond doubt that *Lichanura trivirgata* is perfectly distinct from *L. roseofusca* of northern Lower California and southern California and Arizona. It agrees in coloration with the specimen still in the Philadelphia Academy of Natural Sciences. The snout is strongly protruding. The diameter of the eye is one-third the distance from the orbit to the end of the snout. The true loreals are two on the left and three on the right side. Scale rows forty-one. Gastrosteges two hundred and seventeen.

The following description of its colors was prepared while the snake was yet alive:

Two bands of rich drab-gray, with a slight creamy cast, separating the very dark seal-brown ground color into three longitudinal stripes. Belly and sides creamy white, irregularly dotted and blotched with seal-brown. Head pure drab-gray, with markings of seal-brown above, uniform whitish below.

This snake had the curious habit, often shown by Charina, of coiling itself into a compact mass or ball when disturbed.

5. *On the Type Specimen of Crotalus oregonus.*—In the collection of the Philadelphia Academy of Natural Sciences is a jar which bears two labels, as follows:

Crotalus oregonus Holb., *N. Amer. Herp.*, Vol. iii, Pl. 3. Mr. Nuttall. Type. Oregon.

Crotalus oregonus Holb. 840. Type. T. Nuttall. Oregon.

This jar contains a young rattlesnake which agrees with the original description of *Crotalus oregonus* in all respects except in length and the absence of rattles. The total length is only fourteen and one-eighth inches. I see no reason to doubt that this is the type of *Crotalus oregonus*.

This specimen exhibits all the characters of the species long known under the name *Crotalus lucifer*. The light postocular stripe is more than two scales wide and the dark streak below it begins below the middle of the eye. The snake now almost universally known as *Crotalus lucifer* must, therefore, in the future be called *Crotalus oregonus* Holbrook.

Stated Meeting, April 15, 1898.

Vice-President SELLERS in the Chair.

Present, 12 members.

Donations to the Library were announced and thanks were ordered for the same.

Letters were received from Mr. Robert Patterson, presenting a volume of photographs of the Peale collection of Indian relics in the possession of the Society. It was moved that the best thanks of the Society be given to Mr. Patterson for his gift of the photographs of the Peale collection. Carried.

From Mr. Rosengarten, donating portraits of the Hon. Frederick Fraley and Prof. J. P. Lesley, on behalf of C. C. Harrison, John B. Gest, J. E. Gillingham, Charles Hartshorne, A. T. Freedley, M. H. Messchert, C. H. Clark, John S. Jenks, J. V. Merrick, James P. Townsend, Frank Thomson, Charles Wharton, Alfred C. Harrison, George C. Thomas, Alexander Biddle, Henry N. Paul, W. D. Winsor, W. P. Tatham, Samuel Dickson, Herbert M. Howe, W. W. Frazier, Fanny Rosengarten, Lincoln Godfrey, N. Parker Shortridge, W. V. McKean, John Wanamaker, James C. Brooks, Maria Blanchard, C. S. Wurts, C. A. Griscom, Helen C. Jenks, Coleman Sellers, Robert Patterson, George F. Edmunds, James W. Paul, Jr., and J. G. Rosengarten.

On motion it was *Resolved*, That the best thanks of the Society be presented through Mr. Rosengarten to the donors of the portraits of the Hon. Frederick Fraley and Prof. J. Peter Lesley, and that Friday evening, May 20, be assigned for their formal presentation and acceptance.

Mr. Edmunds, by unanimous consent, presented the report of the Committee appointed on December 3, 1897, to revise the Laws of the Society, and offered the following motion: "*Ordered*, That at the next stated meeting of the Society, the subject of the revision and amendment of the Laws, Regulations and Ordinances of the Society shall have priority of all other business except the reading and approval of the minutes, and if not completed shall have the same priority until disposed of." Carried.

Dr. Hays read a paper entitled "A Journal Kept During the Siege of Fort William Henry, August, 1757."

A paper by Mr. R. H. Mathews was read on "The Divisions of Australian Tribes."

A JOURNAL KEPT DURING THE SIEGE OF FORT WILLIAM HENRY, AUGUST, 1757.

BY I. MINIS HAYS, M. D.

(*Read April 15, 1898.*)

One hundred and fifty years ago the French claimed all of North America from the Atlantic coast range to the Rocky mountains and from Mexico and the Gulf to the northernmost limit, and they had planted flourishing colonies at the mouth of the St. Lawrence and of the Mississippi to control these great waterways, with their tributaries, to the North and West. These vast possessions, which they called New France, had a white population of about 80,000 souls.

The thirteen British colonies were scattered along the Atlantic seaboard from Maine to Georgia, with a white population of about 1,160,000, who were continually extending further and further inland and encroaching upon the undefined area beyond the mountains claimed by both French and English. To maintain their territorial claims by force of arms, with the aid of their numerous Indian allies, and to keep in check the British colonists with their vastly larger population, and to drive back those who were already intruding into the broad valley of the Ohio, the French established a chain of forts and trading posts from Canada to Louisiana. They recognized that the fork of the Ohio and Niagara were the gateways to the great West and they therefore strongly entrenched themselves at these points. Lake Champlain and Lake George on the direct line between Montreal and New York, controlling the gateway to the Hudson, were also important strategic points for the mastery of which both French and English stubbornly contended. In September, 1755, Gen. Johnson defeated the French under Dieskau at the battle of Lake George, and in the following spring

Montcalm was sent out to command the French forces and to retrieve their fortunes. Ticonderoga at the head of Lake Champlain was their most advanced post, while the British troops were entrenched at Fort William Henry at the head of Lake George.

Montcalm in planning his campaign for the summer of 1757 determined, with the aid of his Indian allies, to drive the English back from Lake George, perhaps to capture Fort Edward, fourteen miles to the south, and even to make a demonstration against Albany. In the latter part of July he concentrated his forces at Ticonderoga, and on the 1st of August, with about 7600 men, of whom more than 1600 were Indians, he started his expedition against Fort William Henry, which was commanded by Lieut.-Col. Monro, a brave Scotch veteran, and garrisoned by a force of little more than 2000 men. Gen. Webb was in command at Fort Edward with a force of about 1600 men, with half as many more distributed at Albany and the intervening forts. He promised his assistance, and Col. Monro had every reason to expect it, when Fort William Henry was attacked, but he failed at the last moment to give that support which it was his duty to have rendered. The rest of the sad story is told in the accompanying Journal which was recently found among the papers of Col. James Burd in the possession of this Society.

Col. James Burd was the third son of Edward Burd, a Scottish gentleman, who lived on his estate of Ormiston, near Edinburgh, by his wife, Jane Halliburton, a daughter of the Lord Provost of Edinburgh. He married Sarah Shippen, daughter of Edward Shippen, of Lancaster, Pennsylvania. He held a prominent position in the military forces of this colony, and at the time of the French attack on Fort William Henry he commanded Fort Augusta at the fork of the Susquehanna on the site of the present town of Sunbury, which was one of the long chain of forts that had recently been built by the Province of Pennsylvania to protect its territory in the war with the French and Indians.

Although the individual colonies maintained their independence they were forced to coöperate against the common foe, and the commanders of the frontier posts were kept advised of the movements of the enemy at all points along the line. The following interesting letter from Capt. Thomas Lloyd, also found among the Burd papers, conveyed to Col. Burd information in reference to the French attack on Fort William Henry:

To Major James Burd, Esquire.

Philadelphia, August 9, 1757.

Sir :—We have just now recd. an Express from York informing that Governor De Lancy has marched with an Escort to be shortly follow'd by the whole Militia of that Government and a Demand made of a thousand from the Jerseys to the relief of Fort William Henry which is now invested by two thousand five Hundred french regulars four thousand five hundred Canadians and two thousand Indians with a Train of 36 Cannon and Five mortars against all which damn'd execrable Combination tis Impossible for that Fortress to hold out and the next news that arrives we expect will confirm their mastery of it. I need tell you no more than that I am Sir Yours etc.

T. Lloyd.

Endorsed as "Rec'd 10th Sept. 1757."

It can be readily understood that this accompanying Journal of the capture of Fort William Henry and the subsequent massacre its garrison had a deep personal interest to Col. Burd, which suffices to account for its having been copied and sent to him. Fortunately he was a man of methodical habits and appears to have made a custom of filing and keeping all papers coming into his possession. Hence this copy has been preserved, while the original is unpublished and unknown, and has probably been lost or destroyed.

The French records give full data concerning the capture of Fort William Henry, but accounts written by observers on the English side are very few and, with the exception of Col. Frye's Journal,[1] most meagre. The accompanying Journal by an unknown writer who was evidently an officer within the fort has considerable historical value in not only confirming Col. Frye's account, but also in furnishing some additional details to complete the picture of the bravery of Col. Monro, of the incapacity of the British commander at Fort Edward, and of the treacherous apathy of the French in the face of the savage cruelties committed by their Indian allies on their capitulated foe.

[1] *The Port Folio*, May, 1819, p. 356.

PROC. AMER. PHILOS. SOC. XXXVII. 157. J. PRINTED JUNE 15, 1898.

Copy of a Journal Kept During the Siege of Fort William Henry.

Tuesday
August 2d 1757

In the Evening Col. Young of the 3d Battalion of the Royal Americans and Col. Fry of the N. England Forces came to the Camp at lake George with a reinforcement of 1100 men Regulars and Provincials making with what we had before upwards of 2400 men the whole under command of Col. Monro of the 35th Regiment.

Lieut. Forty of the 35th Regt and Capt. of one of ye gallies detached 14 of his Sailors to reconitre the lake this Evening who returned about midnight and reported that they saw a large number of the Enemys Boats which gave them chace and had like to have been taken. During this night the Camp was frequently alarmed by the Enemys firing on our Centurys.

Wednesday 3d. Early this morning our Century discovered a large number of Boats on the lake close under a point of Land on the west shore distance about 5 miles upon which we fired our warning Guns (32 pounders) a Signal agreed on upon the approach of the Enemy. The French fired at the fort from their Boats lying at the point but their Shot did not reach half way: At this point the Enemy landed their forces and Artillery. This morning we brought in our live Stock put them into the Picquet Store yard but being neglected afterwards strayed and fell into the Enemy's Hands.

Capt. Wm Arbuthnot was ordered out with a Party of his N. England Forces to burn and destroy some Huts and Hedges on the west of the Fort, which he did with difficulty. Nine o'Clock discovered a number of French Regulars marching S. W. near the foot of a Hill distant about 1000 yds which we apprehended were intended to cut off our Communication with Fort Edward. Lieut. Collins of the Royal Regiment of Artillery gave orders to cannonade them as they marched which was done. Our rangers and a party of Provincials were Smartly engaged with enemy S. W. of the Camp on the Ground w[h]ere Sir Wm Johnson engaged and beat the Enemy in the year 1755 and beat them off several times.

Twelve o'Clock we could plainly see from the Fort that the Enemy were throwing up an entrenchment and erecting a Battery at the distance of about 7 or 800 yards on a Clear Ground bearing

N, B, W, Saw several large Boats coming to the Point w[h]ere the Enemy landed.

Two o'Clock Mons^r Mont Calmn sent an officer with a Flag to demand the Fort but the brave Col^o Monro rejected the Summons with Scorn. The Remainder of this day was spent in Bombarding the Enemys works, Capt. McCloud commanding and cannonading. The Artillery fired Several Shot from the Camp which did great Service in beating back the Indians. One of our Balls fell on an Indian Hutt and killed many.

Tuesday [*sic*] 4^th^ Early this morning the Enemy's works were in great forwardness with a ten Gun Battery almost finished. Their Entrenchment approached towards the Fort thus ~~~~~~~~~~ Saw several large Boats coming to the Point w[h]ere the Enemy landed from Ticonderoga: this day we had several Skirmishes from all quarters in which our people behaved with great Bravery, a mortar being pointed towards another Indian Hutt fell on it and killed Several. During this day we cannonaded the French Battery and threw a large number of Shells into their Entrenchm^ts. The Artillery at the Camp kept a Constant fire on the Enemy as they came to Attack our out Guards and Rangers who drove them off into the woods. The Rangers brought in an Enemy wounded Indian but he soon died.

Friday 5^th^ This morning the Enemy began to cannonade our Forts with nine pieces of Cannon 18 & 12 pounders. It was some Time before they could find their mark. At Eleven they tried their Shells, mostly 13 Inches diameter, which fell short but towards the afternoon they got their distance very well, several of their Small Shells falling into the Parade. One of their Shott carried away the Pully of our Flag Staff and the falling of our flag Much rejoyced the Enemy; but it was soon hoisted tho' one of the men that was doing this had his head Shot off with a Ball, and another wounded. A part of the Enemy and their Indian [allies] advanced near our Camp on which the brave Cap^t Waldo of the N. England forces went out to take Possession of a piece of rising Ground near the wood on which a brisk fire unsued on both sides. Col. Monro sent out a second party to Surround the Enemy, but they were forced back and the Enemy advanced up to our quarter Guard. Capt. M. Cloud brought his Cannon to bear upon them soon dispersed them. Here an unlucky accident happened, as some of our men were returning to Camp were taken for the enemy and fired upon by

which Several were killed & wounded. During this Attack poor Cap.t Waldo was Shot and Soon Expired. Cap.t Cunningham of the 35.th Reg.t was wounded in the right arm.

Saturday [6.th] Last night the enemy carried on their Entrenchm.ts and Erected a Battery of 10 Guns mostly 18 Pounders about 6 or 700 yards from us bearing N. W. both of Cannon & Mortars. This was the hotest days action from all quarters; tho' as yet our Garrison remained in high spirits expecting Sir W. Johnson with the Militia and Gen. Liman with the N. England Forces to the number of 3 or 4000 men which we heard were on their march with some more Cannon. Would to God they were permitted to come as their Good will was not wanting. A party of Indians were seen advancing with great Speed towards the road that leads to fort Edward which Confirmed us in our Belief of a Relief.

About 11 o'Clock Mons.r Montcalm sent an officer with a Flag, with a letter that was intercepted by the above mentioned Indians from Gen.l Webb wrote by his Aid-de-Camp M.r Bartman to Col: Monro acquainting him that his Excellency could not give him his assistance as the Militia had not yet come up to Fort Edward, &c. The French officer delivered an other letter from Montcalm acquainting Col: Monro that he came from Europe and Should Carry on the war as a Gentleman and not as the Savages do "but like a true Frenchman, both broke his word and Articles of Capitulation as will appear in the Sequel of this relation. During this interval the Enemy made a Shew of all their Indians, about 1200, on a rising Ground about 250 yards distance bearing S: W: which [while] their Engineers reconitred our old Camp Ground which was afterwards a great Advantage to them. As soon as their Officer returned they began their fire in good Earnest which we returned with the utmost bravery. This day we Split two of our heaviest Pieces of Cannon (viz.t 32 pounders) and our largest Mortar was rendered useless which was very unlucky for us as we could not be Supplied with others in their place. This day Col.o Monro published his orders to all in the Fort that if any person proved cowardly or offered to advise giving up the Fort that he should be immediately hanged over the walls of the Fort and he did not doubt but the officers in the Garrison would stand by him to the last and that he was determined to stand it out to the last or as long as two Legs were together.

Sunday 7.th The Enemy continued plying us very hard with their

Cannon and Bombs while the Compliment was returned by us with all our Artillery, still hoping for a Reinforcement from Fort Edward. A Shell fell into the South Bastion broke one man's Leg and wounded another; Split one of our 18 Pounders and burst a Mortar. Several of the Enemys Shells fell near the Camp S. S E of our Fort about 400 yards distance and on a line with the fort from the Enemys two Batteries, so that their Shot missing the Fort could Strike the Camp. It appeared that the Enemy could throw their Shells 1300 yards. A Shell fell amongst the officers whilst at dinner, but did no other mischief than Spoil their dinner by the dirt it tore up. Another Shell fell into the east or flag Bastion and wounded two or three men.

Monday 8th. We now began to believe we were much slighted, having received no reinforcement from Fort Edward as was long expected. The Enemy were continuing their Approaches with their Entrenchments from the 2d Battery towards the Hill on our old Camp Ground, where they were erecting a third Battery, which would have greatly distressed us: There were frequently during these last 2 or 3 days smart skirmishes near our Camp, but we beat them off the Ground. This night we could hear the Enemy at Work in our Garden, on which some Grape Shott was sent in amongst them, which had good Effect as it drove them off, however they had got their 3d Battery almost finished by Day Light.

Tuesday 9th. This Day the Enemies Lines were finished, parallel to our West Curtain in the Garden, Distance about 150 Yards. Colo. Munro, after a Council of War had been convened, wherein the Officers were of Opinion, that the Loss of our heavy Cannon viz.t 2, 32 pounders, 1, 24 pounders, two 18 pounders, one 9 pounder & 3 Mortars bursting would render it impossible to defend the Fort much longer, as the Enemies Batteries had increased and our Metal failing us, & no help coming, wherefore it was thought advisable that a white Flag should be hung out in order to capitulate; which was done accordingly, and the firing ceased: The Enemy very readily granted the Capitulation: had Monsieur Montcalm been a Man of Honor, he would have performed his part; but instead of that such a Scene of Barbarity ensued as is scarce to be credited: After the Articles were agreed on & signed, the Officers left the Fort to a Regiment of the French Regulars who were ready at the Gate, thro' which we marched with most of our valuable Effects & Arms to the Camp and in the Evening three Companies of the

35th Regimt had marched out & the other three Companies were on their march out of the Breastwork, when we received Orders to return to our Posts again where we remained till next morning.

Wednesday 10th. This morning the Marquis MontCalm being desirous of our being eye witnesses of how well he was able to perform his part of the Capitulation (see the 7th Article), the Indian Doctors began with their Tomhawks to cure the sick and wounded. They began to seize on all the negroes and Indians whom they unmercifully draged over the breast work and scalped. Then began to plunder Colo Youngs and some other officers Baggage on which Colo Monro applyed to Montcalm to put a Stop to these inhuman Cruelties but to no purpose, for they proceeded with out interruption in taking the Officers Swords Hats Watches Fuzees Cloaths and Shirts leaving quite naked and this they did to every one they could lay hands on. By this time the 35th Regt had almost formed their line of March and the Provincials coming out of the breast work the French officers did all they could to throw them into Confusion alledging as soon as the Indians had done stripping them they would fall on and scalp them which thru [*sic*] them in a panick that rushed on the front and forced them into Confusion, the Indians pursued tearing the Children from their Mothers Bosoms and their mothers from their Husbands, then Singling out the men and Carrying them in the woods and killing a great many whom we saw lying on the road side. The greates[t] part and best of the plunder was brought to the french General. Our officers did all in their power to quiet our Soldiers advising them not to take notice but suffer themselves to be stript without Resistance lest it should be Construed as a Breach of our part of the Capitulation and those that were in the rear Should fall a Sacrifice to their unbounded fury. Those therefore that had been able to perserve their arms carried them clubed. The French it is true had a detachmt of their men drawn up as is mentioned in the 1st & 6th Article of Capitulation but their only business was to receive the plunder by the Savages.

FINIS.

DIVISIONS OF AUSTRALIAN TRIBES.

BY R. H. MATHEWS. L.S.

(*Read April 15, 1898.*)

In 1891, my attention was drawn by an article contributed to the Royal Society of South Australia,[1] by the Rev. L. Schultze, to the existence of eight classes or divisions among the native tribes inhabiting the Finke river in South Australia. On making further inquiries, I found that this eight-class system, with different modifications, extends northerly from the Finke river almost to Port Darwin and the Gulf of Carpentaria. It also prevails in a westerly direction, from the boundary of Queensland to that of West Australia, and may therefore be said to be in force over the greater part of the Northern Territory—a name given to the northern portion of South Australia.

Owing to the great apathy regarding native customs shown by the white population sparsely distributed over this immense tract of country, I have experienced much difficulty in obtaining particulars respecting these classes. Among my correspondents I was, however, fortunate enough to find Mr. S. N. Innes, the owner of a station in the Northern Territory. He had read a paper on the class systems of other tribes contributed by me in 1894 to the Geographical Society at Brisbane,[2] which had awakened his interest in the subject, and when I wrote to him he willingly offered to collect particulars of the divisions among the natives in his district.

The tribes reported upon by Mr. Innes are divided into eight classes or sections—the names of the women being slightly different from those of the men in each section. Four of these sections form a group, which may be called A, and the other four sections become group B. This division will be readily understood by means of a table.

It will be seen by the accompanying table that the women of group A are the mothers of the men of group B, who marry the women belonging to the latter group. The women of group B are likewise the mothers of the men who marry the women of group A. In other words, the sons of the women of one group marry the daughters of the women of the other group. Or, what amounts to the same thing,

[1] *Trans. Roy. Soc. S. Australia*, xiv, 210–246.

[2] *Proc. Roy. Geog. Soc. Aust.*, Queensland, x, 18–34.

the men of group A marry the sisters of the men of their own generation in group B, and *vice versa*.

Group.	*Husband.*	*Wife.*	*Children.*	
			Sons.	*Daughters.*
A	Choolum Jamerum Cheenum Yacomary	Ningulum Palyareenya Nooralum Bungareenya	Palyarin Chooralum Bungarin Chingulum	Palyareenya Nooralum Bungareenya Ningulum
B	Chingulum Bungarin Chooralum Palyarin	Noolum Yacomareenya Neenum Neomarum	Yacomary Cheenum Jamerum Choolum	Yacomareenya Neenum Neomarum Noolum

On examining the table further it will be observed that the daughters of the women of group A belong to the same group as their mothers, but to a different section or class of it. For example, Ningulum has a daughter Palyareenya; Palyareenya produces Nooralum; Nooralum produces Bungareenya; Bungareenya is the mother of Ningulum, and this series is continually repeated. The women of the A group pass through each of the four classes in as many generations—the same class name reappearing in the fifth epoch. If our example had been taken from the B group, an analogous result would have been obtained.

When on the Culgoa river some years ago I collected some information respecting a large tribe speaking the Moorawarrie language, who occupy the country from about Goodooga on the Bokara river to Barringun on the Warrego, extending southerly about fifty miles and northerly into the Queensland frontier about the same distance. They are divided into four sections, having the same names for the men and women as those of the Kamilaroi tribe, with rules of marriage and descent as exemplified in the following table:

Husband.	*Wife.*	*Sons and Daughters.*
Ippai,	Kubbitha,	Murri and Matha,
Kumbo,	Matha,	Kubbi and Kubbitha,
Kubbi,	Ippatha,	Kumbo and Butha,
Murri.	Butha.	Ippai and Ippatha.

The whole community is divided into two groups—the members of the Ippai and Kumbo sections forming the one, and the Kubbi and Murri people constituting the other. The families composing these groups bear the names of different animals, plants, or inanimate objects, which are called *totems*, a word copied by us from the North American Indians. Among the totems of the people constituting the Ippai and Kumbo sections may be mentioned the following:

Wirroo (parrot),	Bilbee,	Mulga Snake,
Emu,	Gray Kangaroo,	Red Kangaroo,
Native Dog,	Jewfish,	Bronze-wing Pigeon,
Codfish,	Swan,	Plain Turkey,
Bream,	Native Companion,	Common Ants,
Gray Frog,	Jew Lizard,	Wood Duck,
Common Fly,	Galah,	Native Cat,
Spider,	Kangaroo Rat,	Top-knot Pigeon,
Plover,	Grasshopper,	Muscle,
Curlew,	Cocklarina,	Bush Mouse,
Water Hen,	Copi (Moganderra),	Blue Bonnet (parrot),
Sun,	Hail,	Clouds,
Rain,	Rainbow,	Lightning,
North Wind,	West Wind,	Thunder,
Birribil,	Numumbeera,	Cuttibundi,
Doomul,	Mulga,	Carbeen,
Gidyer,	River Gum,	Bloodwood,
Myall,	Belar,	Leopard Tree,
Kurrajong,	Quandong,	Grooee,
Supple Jack,	Whitewood,	Greenwattle,
Tea Tree,	Hop Bush,	Wild Orange Tree,
Lime Tree,	Yams,	Lignum,
Nardoo (Bah),	Blue Grass,	Mitchell Grass.
Pig-weed,	Sensitive Plant,	

The under-mentioned totemic names may be enumerated as belonging to some of the people comprising the Kubbi and Murri sections:

Ground Iguana,	Padamelon,	Opossum,
Carpet Snake,	Brown Snake,	Black Duck,
Eagle Hawk,	White Cockatoo,	Pelican,
Fish Hawk,	Dove,	Bower Bird,
Tree Iguana,	Porcupine,	Black Snake,
Crow,	Death Adder,	Native Bee,
Scrub Turkey,	Silvery Fish,	Flying Squirrel,
Common Magpie,	Black Magpie,	Green Frog,

Cross Frog,	Shingle-back,	Jackass,
Mopoke,	Turtle,	Wasp,
Centipede,	White Crane,	Blue Crane,
Ibis,	Crimson-wing Parrot,	Shag,
Diver,	Wood Adder,	Scorpion,
Butterfly,	Bull-dog Ant,	Moon,
South Wind,	East Wind,	Quartz Stone,
Midjeree,	Brigalow,	Coolaba,
Ironbark,	Pine,	Sandalwood,
Apple Tree,	Box,	Mungal,
Cherry Tree,	Wirribil,	Barley Grass.
Nepon Tree,		

East of the Moorawarrie is a large tribe speaking the Uollaroi dialect; they have the same sectional divisions as the former, and with some variations their totems closely agree. In both tribes descent is reckoned through the mother. In gathering the particulars respecting the Moorawarrie tribe, now for the first time published, I desire to thank Mr. J. E. Miller, of Goodooga, for his willing assistance.

Stated Meeting, May 6, 1898.

Vice-President PEPPER in the Chair.

Present, 12 members.

Dr. Edward Pepper was presented to the Chair, and took his seat as a member.

A communication entitled "Contributions to a Revision of the North American Beavers, Otters and Fishes," by Samuel N. Rhoads, was presented for publication in the *Transactions*. It was referred to a Committee consisting of Mr. Arthur E. Brown, Mr. Pilsbry and Dr. Jayne.

Mr. Edmunds made a statement on behalf of the Committee on the Amendments of the Laws, and moved that when the Society adjourn, it adjourn till 3 P.M. on Friday, May 13. Carried.

Adjourned Meeting, May 13, 1898.

Vice-President PEPPER in the Chair.

Present, 27 members.

The consideration of the amendments to the Laws being in order, Mr. George F. Edmunds, on behalf of the Committee proposing the amendments, made a statement concerning the amendments proposed, and on motion the Laws and Ordinances were adopted in conformity with the Charter as follows:

THE LAWS OF THE AMERICAN PHILOSOPHICAL SOCIETY.

CHAPTER I.

OF THE MEMBERS, AND MANNER OF THEIR ELECTION.

SECTION 1. The election of members shall be by ballot, and shall form part of the stated business of the meetings on the third Fridays of February, May, October and December.

2. A member may, at any meeting, nominate in writing a candidate for membership, and the nomination so made may, in like manner, be concurred in by other members. The board of officers and council may also nominate candidates for membership; and such nominations shall be certified to the Society by a minute thereof in writing, attested by the clerk of said board.

3. No person shall be balloted for, unless his nomination, with the names of the members proposing him, or the minute of the board of officers and council, made as aforesaid, shall have been publicly read to the Society at the two stated meetings preceding that at which the balloting takes place. Nor shall any person be deemed duly chosen unless three-fourths of the votes given shall be in his favor.

4. Before entering upon an election for members, one of the secretaries shall read the names of the several candidates; and any member may then, for the information of the Society, speak to their character and qualifications for membership.

5. The names of the candidates and their places of abode shall be designated on the ballots, and the names of the officers shall be

called, in the order of their seniority, by the acting secretary, the members thereafter depositing their ballots. The name of a candidate struck from a ballot or not voted for shall be considered as a vote adverse to that candidate.

6. At the conclusion of the balloting the ballot box shall be opened by the secretaries, or, in their absence, by two tellers to be appointed by the presiding member, who shall then declare to the Society the result of the poll.

7. The members are mutually pledged not to mention out of the Society the name of any candidate proposed, nor of any withdrawn or unsuccessful candidate; and the papers containing the names of the unsuccessful candidates shall be destroyed immediately after the election.

8. Every member, upon his introduction into the Society, shall be presented to the presiding officer, and shall subscribe the laws. The signatures of members to the Roll shall be deemed an agreement to adhere to the laws of the Society.

9. Such members as reside within thirty miles of the hall of the Society, shall pay an admission fee of ten dollars, and annually thereafter, on the first Friday of January, a contribution of five dollars; and such other members as desire to vote, may do so at any meeting, upon the payment of ten dollars and one year's dues; and they shall, thereafter, pay the annual contribution of five dollars. The payment of one hundred dollars at one time, by a member not in arrears, shall exempt him from all future annual payments.

10. Members-elect, residing within thirty miles of the hall, shall lose the right of membership unless they subscribe the roll, and pay their admission fee within one year after their election. Any member liable to an annual contribution, who shall neglect or refuse to pay the same for the term of one year shall be notified by the treasurer in writing, on or before the second Friday in January after such default, or as soon thereafter as may be, that his rights as a member are suspended; and in case the said arrears together with all contributions then due shall not be paid to the treasurer on or before the expiration of sixty days next after such notice, the membership of such defaulting member shall be forfeited, his name stricken from the roll, and reported to the Society by the treasurer.

Chapter II.

OF THE OFFICERS, AND MANNER OF THEIR ELECTION.

Section 1. The officers shall be a patron, a president, three vice-presidents, four secretaries, three curators, a treasurer, and twelve councillors.

2. The governor of the State of Pennsylvania shall be, ex-officio, the patron of the Society.

3. On the first Friday of January in every year, between the hours of two and five in the afternoon, as many of the members as shall have paid up their arrears due to the Society, and shall have declared their willingness to conform to the laws, regulations, and ordinances of the Society, then duly in force, by subscribing the roll, and who shall attend in the hall, or place of meeting of the society, within the time aforesaid, shall choose by ballot one president, three vice-presidents, four secretaries, three curators, and one treasurer; and at the same time and place the members, met and qualified as aforesaid, shall in like manner choose four members for the council, to hold their offices for three years. Nominations for the elective officers of the Society shall be made at the stated meeting next previous to the day of election. If there should occur a failure of qualified candidates so nominated, others not so nominated may be elected. All officers shall hold office, unless lawfully suspended or removed, until their successors are duly elected and accept.

4. No person residing within the United States shall be capable of being president, vice-president, secretary, treasurer, or member of the council, or of electing to any of the said offices, who is not capable of electing and being elected to civil offices within the State in which he resides.

5. Of the day, hour, and place of election, notice shall be given by a secretary at least one week before the day of election, in such one or more of the public newspapers of the State of Pennsylvania as the Society shall direct. At the stated meeting next before the election the Society shall appoint three of its members to be judges of the election, and also two clerks for taking down the names of the voters. If at the time of election there should occur a failure of the full number of judges or clerks to be present for the performance of their duties, the electors present shall appoint a member or members to fill up the number. The poll shall be opened at two o'clock in the afternoon and be closed at five o'clock in the afternoon.

6. A vacancy occurring in any elective office may be filled for the unexpired term by a vote by ballot taken at any stated meeting after notice of such vacancy shall be given and nominations made and entered in the minutes at a previous stated meeting. Notice that such election will be held shall be given in the notice of the meeting. At any such election the qualifications of voters shall be the same as at the annual elections. At such election three judges shall be appointed and the secretaries on duty shall act as clerks.

Chapter III.

of the president and vice-presidents.

Section 1. The president and the vice-presidents shall perform such duties as the rules of administration and order shall prescribe.

Chapter IV.

of the secretaries.

Section 1. The secretaries shall perform such duties as the rules of administration and order shall prescribe.

Chapter V.

of the curators.

Section 1. The curators shall perform such duties as the rules of administration and order shall prescribe.

Chapter VI.

of the treasurer.

Section 1. The treasurer shall perform such duties relating to his office as the rules of administration and order shall prescribe.

Chapter VII.

of the officers and council.

Section 1. The officers and council shall perform such duties as the rules of administration and order shall prescribe.

Chapter VIII.

of the librarian.

Section 1. A member of the Society shall be chosen at the stated meeting on the third Friday of January in each year, to be the librarian of the Society. Nominations for said office shall be made at the first stated meeting in January, and no person shall be voted for who has not been so nominated, but if there shall have been a

failure of qualified candidates so nominated, one of others not so nominated may be elected. The duties of the librarian shall be prescribed by the rules of administration and order of the Society.

Chapter IX.

of the meetings of the society.

Section 1. The stated meetings of the Society shall be on the first and third Fridays of every month from October to May inclusive, at eight o'clock in the evening. Special meetings may be called at any time by order of the president; or, in his absence or disability, by order of a vice-president. And it shall not be lawful to take up, consider or transact at such special meeting any business other than that which is specified in the call and the notice for the meeting. Should the time for any stated meeting, other than the meeting on the day of an annual election, fall on a legal holiday, such meeting shall not be held on that day, but shall be held on the next Friday.

2. Twenty qualified voters, of whom seven shall be members of the officers and council, present at any stated or special meeting, shall be a quorum, and be competent to elect members, dispose of property, appropriate money, and award premiums; but no property shall be alienated or encumbered, except by the vote of three-fourths of the qualified voters present, and given at two successive stated meetings. For the transaction of the ordinary business, the reception and reference of communications on literary, scientific, or other subjects, the members present shall be deemed competent to act, and shall form a quorum.

3. Those members shall be considered qualified voters at the meetings who have subscribed the roll and paid the admission fee, and who are not in arrears to the Society.

Chapter X.

of standing and special committees.

Section 1. There shall be chosen, at the stated meeting on the third Friday of January in each year, three members of the Society to be a committee of finance, five to be a committee of publication, three to be a committee on the hall, and five to be a committee on the library. Such other committees may be constituted from time to time as the Society shall think expedient.

2. The committee of finance shall have the general superintendence of the financial concerns of the Society. They shall consult with the treasurer, and with any custodian of the Society's property, and authorize and direct investments of its surplus funds. They shall always have access to his books, accounts, and vouchers; and they shall annually audit the same, and on the second Friday of December file with the secretaries a full report on the state of the treasury, particularly distinguishing the several funds, and the income and disbursements of each, and recommending the amounts which should be appropriated for different objects of expenditure during the ensuing calendar year. They shall also have power, subject to the approval of the council, to remit the fees and contributions of members.

3. The committee of publication shall perform such duties in respect of publications as shall be prescribed by the rules of administration and order.

4. The committee on the hall shall perform such duties in respect of the hall and matters incidental thereto as shall be prescribed by the rules of administration and order.

5. The committee on the library shall perform such duties in respect of the library as shall be prescribed by the rules of administration and order.

6. No committee appointed on any subject of deliberation shall consist of less than three members; but any other matter may be committed to a single member. A majority of any committee shall be a quorum.

7. No officer or committee, or other body of the Society, shall have power to incur any expense, or to charge the Society with any debt or other obligation, without the authority of the Society previously given.

Chapter XI.

of rules of administration and order.

Section 1. Rules of administration and order not inconsistent with the charter and laws of the Society may be made and changed from time to time by the stated meetings; but no rule shall be changed, rescinded or suspended otherwise than in the manner provided by the rules, or in respect of change or rescission, upon written notice publicly given at a stated meeting, showing the particular change or rescission proposed, and agreed to at the next stated meeting.

Chapter XII.

of the laws of the society.

Section 1. No statute, law, regulation, or ordinance shall ever be made or passed by the Society, or be binding upon the members thereof, or any of them, unless the same hath been duly proposed and fairly drawn up in writing, at one stated meeting of the Society, and enacted or passed at a subsequent meeting, at least the space of fourteen days after the former meeting, and upon due notice in some of the public newspapers, and in notices sent by mail to the members whose addresses shall have been furnished to the secretaries, that the enacting of statutes and laws, or the making and passing ordinances and regulations, will be part of the business of such meeting.

2. Nor shall any statute, law, regulation, or ordinance be then, or at any time, enacted or passed, unless twenty members of the Society be present in addition to the quorum of the officers and council; nor unless the same be voted by two-thirds of the whole body present.

Ordinance No. 1.

It is hereby ordained and declared that the foregoing twelve chapters shall be hereafter the laws of the Society. And all laws heretofore existing on the subjects embraced in the said twelve chapters and all ordinances, regulations, rules and orders inconsistent therewith be and the same are hereby repealed.

Ordinance No. 2.

And it is further hereby ordained that all laws, regulations and orders of the Society not embraced in the foregoing provisions shall, for the time being, stand and be in force as the rules of administration and order of the Society until they shall be repealed or changed in conformity with the provisions of Chapter XI of the laws now enacted.

Mr. Edmunds moved that the Chair appoint a Committee of five members to report at the earliest practicable opportunity a body of rules of administration and order of the Society. Carried.

PROC. AMER. PHILOS. SOC. XXXVII. 157. K. PRINTED JULY 6, 1898.

Mr. Dickson, Mr. Ingham, Dr. Hays, Dr. Jayne and Mr. Pettit were appointed as the Committee.

A report was presented from the Special Committee appointed on the paper of Mr. Rhoads, entitled "Contributions to a Revision of the North American Beavers, Otters and Fishes," in favor of its publication in the *Transactions*, and it was so ordered.

Stated Meeting, May 20, 1898.

Vice-President PEPPER in the Chair.

Present, 35 members.

Donations to the Library were laid on the table, and thanks were ordered for them.

Prof. Albert H. Smyth, presenting the portrait of Mr. Frederick Fraley, said:

It had been the intention and the hope of Mr. J. G. Rosengarten to be present this evening and in accordance with the request of the subscribers, to present to the American Philosophical Society two portraits, one of Mr. Frederick Fraley, our honored President, the other of Prof. John Peter Lesley, for many years a Vice-President of this Society.

But Mr. Rosengarten is prevented from being here, and has asked me to act in his stead.

In the long and distinguished history of the American Philosophical Society, fifteen Presidents, from Franklin to Fraley, have successively presided over its meetings and guided its policy. Portraits of all these—Franklin, Rittenhouse, Jefferson, Wistar, the Pattersons, the Baches, Tilghman, Duponceau, Chapman, Kane and Wood—hang upon our walls, together with many of that illustrious company who have contributed to the scientific and the literary glory of the Philosophical Society.

A little while ago several of the friends of Mr. Fraley, within and without this Society, desiring to express, as Hamlet says, their "love and friending" to him, and to place in the Hall of the Society over which he has presided with such zeal and success some

token of their admiration and respect, learned that an excellent portrait of him had been painted.

Subscriptions were promptly made to a fund for the purchase of it and the portrait was obtained.

Upon the twenty-eighth of this month, Mr. Fraley, whose extraordinary activities cover well-nigh a century of time, will celebrate his ninety-fourth birthday; and this therefore being the meeting of the Society nearest to that happy anniversary has been chosen for the formal presentation.

In behalf of the subscribers, I present to the American Philosophical Society this portrait of Mr. Frederick Fraley.

Prof. Prime moved that the thanks of the Society be tendered to those gentlemen who presented the portraits, and that the said portraits shall be hung on the walls of the Hall, and shall be under the care of the Curators.

HAMPTON L. CARSON, Esq., in accepting the portrait of Mr. Fraley, in behalf of the Society, said:

The agreeable duty has been assigned to me of speaking in support of the Resolution of acceptance in behalf of the Society, and I respond with peculiar pleasure; first, because I am aware of the value of the services rendered to us for so many years by our venerable and venerated President, and next, because I cherish for him personally the most affectionate and reverential regard. I look back over thirty years of my own recollections, and I see him foremost in all measures tending to promote the commerce, finance, manufactures and mechanic arts of Philadelphia, and a leader in all movements to extend her civic industrial and educational influence. I look beyond into the history of the preceding forty years, and I still see him conspicuous, even at an early age, among many honored men who have long since passed to their reward.

At the age of twenty he was one of the founders of the Franklin Institute, and has been a member for seventy-four years. At the age of thirty he was a member of our City Council, serving as Chairman of the Finance Committee, a pilot standing at the helm with clear head and steady hand, during the troubled period of 1837. He was an earnest advocate, in opposition to the views of such men as Horace Binney, of the introduction of gas as a means of lighting our City. He was at his post in the State Senate

during the Buckshot War, and was active in drafting the laws called for by our amended State Constitution. He was the author of the preamble of our Consolidation Act, and his skillful hand was present in the shaping of those sections which concerned the administration of our finances. He was a leader in the establishment of the Paid Fire Department, after having long served as a volunteer member of the old Philadelphia Hose Company. He was one of the founders of the Union Club, which developed into the splendid organization of the Union League. For forty-one years he has been a manager of the Western Saving Fund, and its President for twenty years. For forty-five years he has served as a trustee of the University of Pennsylvania. For fifty-six years he has been a member of this Society, and has been its President for eighteen years. As President of the National Board of Trade, and of our own local organization, as a member of the Board of Finance of the Centennial Commission, and in many other capacities, his voice has been raised and his influence has been exerted in unselfish devotion to the greatest of public interests.

His long and varied career stands for unbending integrity in the discharge of trust duties; for knowledge and power in the discussion of public questions; for breadth and liberality of opinion; for constant progressiveness and generous hospitality to new ideas; for lofty ideals supported by trained technical skill. He has walked on the high places of this earth with undimmed eye and steadfast courage. The loftiness of his position enabled him to see the tops of distant thoughts which men of common stature never saw. With him "Knowledge was not a couch whereon to rest a searching and restless spirit; nor a terrace for a wandering or variable mind to walk up and down with a fair prospect; nor a tower of state for a proud mind to raise itself upon; nor a sort of commanding ground for strife and contention; nor a shop for profit and sale, but a rich storehouse for the glory of the Creator and the relief of man's estate."

At the end of ninety-four years of life, with none of the intellectual infirmities of age, and without the slightest trace of acerbity of temper, he stands in the golden glow of an honorable and useful career, the central object of our affection, of our veneration and esteem.

It is fitting that his portrait should grace these walls—walls hallowed by sacred associations and cherished with filial piety.

"I would rather," said Hazlitt, "leave behind me a good portrait than a good epitaph." The sentiment is just. Those who read tombstone inscriptions are few, but those who can find inspiration in the study of a well-pictured face are many. This Society, grateful to the donors of this admirable portrait, will direct it to be hung beside those of the illustrious men who were his predecessors, in commemoration of the virtues, the talents and the services of Frederick Fraley.

Mr. SMYTH, in presenting to the Society the portrait of Prof. Lesley, said:

At the same time that the portrait of Mr. Fraley was obtained it was learned that a portrait of Prof. J. P. Lesley was obtainable; the subscription fund was immediately enlarged and the second portrait was procured. I must not omit to add that both are the admirable work of the same excellent artist—Mrs. Margaret Lesley Bush Brown, a daughter of Prof. Lesley.

In behalf of the subscribers, I present both these portraits to the American Philosophical Society.

Mr. WILLIAM A. INGHAM said:

In speaking to the resolution accepting the donation of Prof. Lesley's portrait tendered this evening to the Society my words shall be few and I hope fit.

This portrait of Prof. Lesley by his daughter is to me a most speaking likeness. It shows him as I have seen him a hundred times sitting in his chair, roused up from a reverie by some remark, whether opposing his views or corroborating them (it made little difference), but rousing him up and starting him off, active and alert on an animated discourse which might last an hour.

I have seen him thus often, and I prefer to remember him thus, if it shall so happen, that in the course of nature he shall go before me to join the majority. I am not competent (who is?) to pronounce on his eminent qualities as a geologist and scientist.

Prof. Lesley was an assistant on the First Geological Survey of the State, and has written a history of that Survey, published in Volume A of the Reports of the Second Survey.

The First Survey was completed in 1858 by the publication of the

Final Report, but some years prior to that date the corps was disbanded and Prof. Lesley had turned his attention to other matters.

He was Secretary of the American Iron and Steel Association for six years, and during that time he published *The Iron Manufacturers' Guide* (1856), which is a complete list of the active furnaces in the United States and a very complete discussion of the iron ores.

Of course much of this is now obsolete, but at the time it was the first and only manual on the subject.

About the same time he published his *Manual of Coal.*

This little book, a model of its kind, contains, first, a description of the coals of Pennsylvania, remarkable for its accuracy, and, second, a concise treatise on "Surface Geology." In this the author insists on the importance of topography as an adjunct to geology.

Prof. Spencer, in a recent address (*Popular Science Monthly*, May, 1898), says, "Geomorphy is the outgrowth of topography, *which was made a science* fifty or sixty years ago by Prof. J. P. Lesley and his coworkers. Its birth is graphically described by the author himself."

And from the very beginning of the Second Geological Survey, Prof. Lesley has always insisted on the importance of topography as preliminary to geology. This is shown by the repeated efforts of the Board at his instigation to obtain an appropriation for a topographical survey. The failure of these efforts will account for the fact that the Second Geological Survey is not as satisfactory as it might have been made.

It seems strange at this date that any argument should be necessary in favor of topography as preliminary to geology.

After the disbandment of the First Survey, Prof. Lesley was constantly occupied as an expert geologist—which work took him all over our State and into adjoining States. He became thoroughly familiar with every square mile of the State geologically and geographically.

In this time he made frequent professional visits to Europe, where he made acquaintance with all eminent geologists, many of whom became his life-long friends.

In one of these visits he saw that the key to the complicated structure of the Jura was to be found in Pennsylvania, and Desor came over here and learned from us how to interpret the Jura problem.

This varied professional experience, as evinced in his reports to

his employers (one of which, on the Nittany Valley ores, a model of geological work, has been published), but most of which are in the archives of his employers—his numerous publications in the PROCEEDINGS of our Society, his general repute as to familiarity with the geology of the State, combined to make him the choice for State Geologist under the act of 1874.

He was Librarian of this Society part of the time and Secretary all the time from 1858 to 1887.

He was Vice-President from 1887 to 1898.

My personal intercourse with Prof. Lesley began with the organization of the Second Geological Survey in 1874.

Since that time he as State Geologist and I as Secretary have been in the most intimate connection.

In that period of over twenty years I have been impressed with his unselfish motives, supervising the field work of his assistants with the sole idea, (1) of the good of the Survey, and (2) that every man should receive full credit for his work.

He is a thorough, unselfish, impartial man of science.

It is largely due to Prof. Lesley, in continuing across this State the work begun by Prof. Cook in New Jersey on the terminal glacial moraine, that the wonderful recent revival of interest in surface geology is due. The modern geology which attempts to account for the present condition of the earth's surface may almost be said to date from the survey of the terminal moraine.

Aside from geology, Prof. Lesley, in his Lowell lectures, delivered in 1865–1866, on the "Origin and Destiny of Man," branches far afield into Egyptology and Theology. In these subjects, which he merely touches, he shows the hand of a master.

A list, possibly imperfect, kindly prepared for me by Miss Morrison, is hereto appended of Prof. Lesley's contributions to our PROCEEDINGS. The titles number sixty-nine, on almost every subject conceivable. But besides these printed papers, he has often delighted the Society with impromptu remarks on matters pending. We all remember how brilliant these impromptu remarks were; how he illuminated what was obscure and explained what was confused. Sad to say, no record of these speeches has been preserved.

In the preparation of this brief and inadequate sketch, it has been my duty and pleasure to read again some of Prof. Lesley's publications, and I have been impressed more than ever with his amazing versatility, with the power of his imagination, illuminating every

subject with flashes of genius, with his perfect command of language and his profound thought.

His introductory chapters to the Final Report of the Second Survey (a most unequal work, part of which was written under stress of physical and nervous depression), particularly the chapters on "Geological Time," "Geological Space" and "The Appalachian Sea," with his other works previously mentioned, deserve record here. These show that he is not a narrow-minded, one-sided person; that his scope embraced the sphere of human knowledge, of course with limitations, as no man is omniscient. After all, his monument is to be found in the publications of the Second Geological Survey, 120 volumes, a library in itself.

It is our pride that he belongs to us. It is our pleasure that we have now a portrait of him which may serve to perpetuate his likeness to those who shall come after him, and who will reap, perhaps unwittingly, the harvest from seed which he has sown.

Communications Published in the TRANSACTIONS *and* PROCEEDINGS *of the American Philosophical Society, by Prof. J. P. Lesley.*

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Artesian Wells in Montgomery County, at Norristown, Washington Square, Worcester Township, Flourtown, Williams Station, King of Prussia; Parkesburg, Chester County; Radnor, Delaware County, and Philadelphia, by Oscar C. S. Carter and J. P. Lesley..... " " 43

The resolution of acceptance of the portraits was then unanimously adopted.

Dr. Frazer presented the report of the Officers and Council.

The Secretaries announced the death, on May 19, 1898, of the Rt. Hon. William Ewart Gladstone, at Hawarden, Chester, England.

Pending nominations Nos. 1432 and 1451 to 1468 were read and spoken to, and new nomination No. 1409 was read.

A paper by Dr. William C. Day, entitled, "The Production of an Asphalt Resembling Gilsonite by the Distillation of a Mixture of Fish and Wood," was read.

The Secretaries reported the election of the following as members:

Edward F. DeLancey, of New York.
Prof. William Harkness, of Washington.
Prof. C. P. Tiele, Ph.D., of Leyden.
Alfred H. Allen, F.C.S., of Sheffield, Eng.
Boverton Redwood, F.R.S., of London.
Prof. Albert B. Prescott, LL.D., of Ann Arbor.
Prof. William H. Pettee, of Ann Arbor.
Prof. R. P. Whitfield, of New York.
H. LaBarre Jayne, of Philadelphia.
Lamar Gray Patterson, of Cumberland, Md.
Charles Platt, of Philadelphia.
John H. Converse, of Philadelphia.
Henry Grier Bryant, F.R.G.S., Lond., of Philadelphia.
Emlen Hutchinson, of Philadelphia.
Prof. G. Mangarini, Ph.D., of Rome.

The meeting was then adjourned by the presiding officer.

THE PRODUCTION OF AN ASPHALT RESEMBLING GILSONITE BY THE DISTILLATION OF A MIXTURE OF FISH AND WOOD.

(Plate X.)

BY WM. C. DAY.

(*Read May 20, 1898.*)

A few years since, I undertook a rather detailed experimental study of the variety of asphalt known as gilsonite,[1] which is mined for commercial use in Utah. Gilsonite is a black, glistening, brittle material, yielding a dark-brown powder when finely pulverized. It fuses readily, becoming a liquid which begins to boil at a temperture above the limit of a mercury thermometer.

It is entirely soluble in carbon bisulphide, not entirely soluble in ordinary ether, partly soluble in absolute alcohol, petroleum ether, glacial acetic acid and chloroform, imparting to these solvents a yellowish to red color with green fluorescence. Besides carbon and hydrogen, it contains sulphur, nitrogen, a trace of oxygen and one-tenth of one per cent. of ash.

Among the various products which I obtained by distilling gilsonite may be mentioned as of interest in this connection certain nitrogenous bases extracted from the distillates by the action of dilute acid and precipitated therefrom by alkalies. These bodies have an odor like that of the pyridine and quinoline series. Such substances were first obtained from bitumen by Prof. S. F. Peckham, who noticed them in distillates from California petroleum; later by myself from an asphalt occurring in Coos county, Oreg., also in the product which forms the subject of this paper.

As a result of considerable experimental work in the past few years with asphalts from a variety of sources in the United States, together with a study of the literature pertaining to the question of the origin of the bitumens from both the geological and the chemical standpoints, I became impressed with the belief that the solid and also some of the higher boiling liquid bitumens have been formed in the earth by the distillation of mixed animal and vegetable material, together with steam at high temperatures, but at pressures which may or may not have been high. Petroleum distillates have been obtained by Warren and later by Engler from fish oil,

[1] *Journal Franklin Institute*, Vol. clx, p. 221.

and still more recently by Sadtler from linseed oil. In addition to liquid distillates, paraffin has also been obtained by these investigators. No mention, however, of an analogous production of asphalts, so far as I am aware, has ever been made.

To test the correctness of the belief already expressed, I tried the following experiments:

Into a cylindrical iron retort were introduced a number of fresh herring, a quantity of pine saw dust and a number of small pieces of fat pine wood. The retort was connected by plaster-of-Paris joints with a short glass tube, and this with a gas pipe four feet long, the latter being placed in an ordinary combustion furnace, the other end of the pipe was connected with a Liebig's-cold-water condenser.[1] After charging and closing the retort, it was heated by means of gas stoves, which together with the retort were surrounded with loose bricks to prevent the loss of heat. The heating of the retort was regulated by the rapidity with which vapors were evolved, an increase of heat being necessary toward the end of the distillation. The gas pipe was simultaneously heated to bright redness by the combustion furnace. The pressure was that of the atmosphere. During the progress of the distillation water and oil together with a white smoke flowed from the condenser into the receiver. The oil obtained was lighter than water, of bad odor and very dark red in color. At the end of the gas pipe next to the retort carbon separated, and on one occasion nearly choked the pipe. Only once was an oil heavier than water obtained, and this was small in amount.

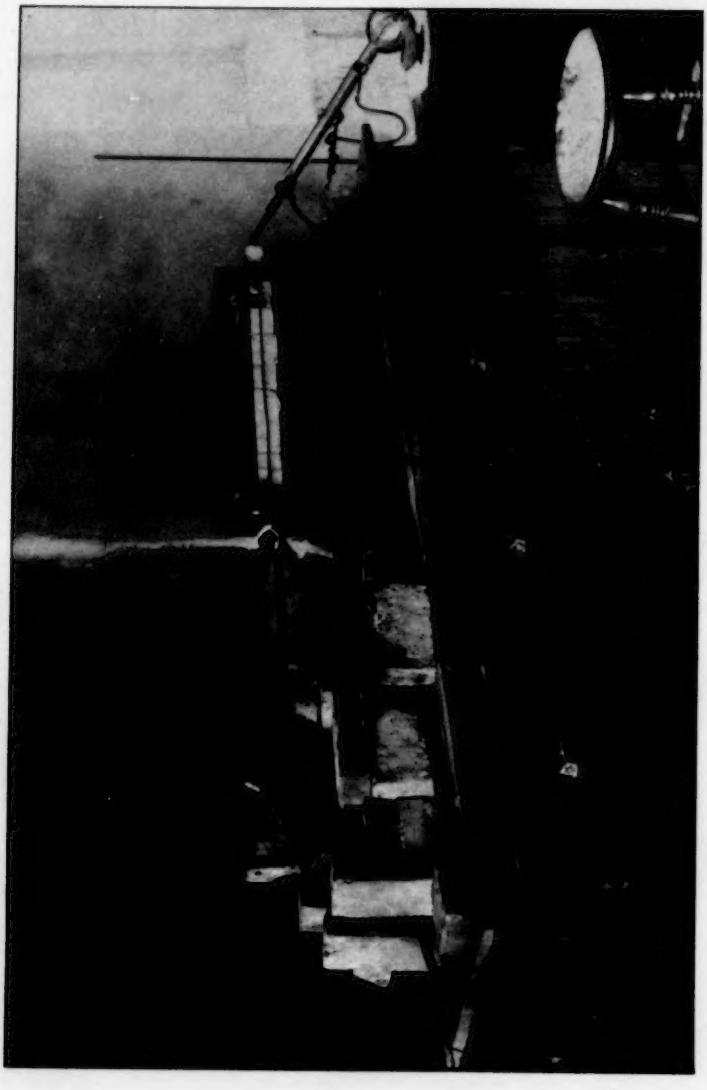
The condensed oil was separated from the water on which it floated, and finally completely dried over chloride of calcium.

It was then placed in a distilling bulb provided with thermometer and distilled, using a straight glass tube as an air condenser.

Boiling began at about 100 Centigrade, but the mercury soon rose to 120. The distillate between these limits consisted of a lemon-yellow mobile oil together with a few drops of water.

At 120 C. the receiver was changed, and another fraction darker in color and less mobile was obtained while the mercury rose to 180. The third fraction was collected between the limits 180 and 245; the fourth between 245 and 315, this fraction showing a pronounced greenish fluorescence, the color by transmitted light being

[1] See accompanying photograph.



dark red. At 340 the receiver was again changed, the thermometer removed and the distillation continued until the temperature was (at a guess) about 425 Centigrade. At this point the distilling bulb cracked and the operation was stopped. On cooling, the contents of the bulb became a black brittle solid, showing a very pronounced resemblance to gilsonite in every way. The following are its properties: Black glistening color, becoming brown on pulverizing, and slightly darker than gilsonite; fracture conchoidal, entirely soluble in carbon bisulphide; ether dissolves 90.6 per cent.; alcohol 66.3 per cent.; petroleum ether 61.1 per cent. All these solutions show greenish fluorescence, while the color by transmitted light varies from yellow to reddish.

As already stated, the distilling bulb cracked before I had decided to stop the distillation, and the solid product being slightly sticky to the touch, I distilled a second portion of oil, collecting the same fractions as before, but continuing the heating longer. This time I obtained a solid so like gilsonite that it was difficult to tell which was which. A combustion of the first sample gave carbon, 87.5 per cent., and hydrogen, 7.7 per cent. A combustion of the second sample gave carbon, 88.9 per cent., and hydrogen, 6.7 per cent. The figures for Utah gilsonite are 88.3 for carbon and 9.9 for hydrogen. At the time (three years since) I made the analysis of gilsonite nitrogen was not determined. Recently I have determined the nitrogen, and found it to be 1.96 per cent. Since the carbon, hydrogen and sulphur figures added up to 99.5 one or all of the three must have been high, and I am inclined to think that it was the hydrogen, since I cannot now be sure that the gilsonite sample was entirely dry.

The agreement in properties and composition between the gilsonite and my product is much more perfect than it would have been reasonable to expect at the outset of the experiment, particularly when it is remembered that both are doubtless mixtures in themselves, and that certainly on distillation they yield highly complicated mixtures of hydrocarbons.

As the product under discussion was obtained only a few days ago, I have not had time to carry the investigation further, but enough has been done to show how a solid asphaltum may have been formed in nature and to afford a rather satisfactory demonstration of the correctness of views entertained by a number of scientists who have formed their opinions largely on geological evidence and the study of natural occurrences.

It should be stated, in addition, that for the sake of comparison, fish alone, *i. e.*, without wood, were subjected to distillation and without passing the vapors through the red-hot tube. The products obtained included nothing that bore any resemblance to gilsonite and they were radically different from the products which accompanied the distillation of fish and wood together.

This brief paper is of course only preliminary to one which should consider the literature of the subject more in detail, and which may, I trust, throw some light on a few of the many problems which naturally suggest themselves.

I shall continue the work as rapidly as my limited time and facilities for such study will permit. In conclusion I take pleasure in expressing my obligations to my assistant, Mr. Eugene Leamy, for his very intelligent and effective aid in carrying on the experimental work.

SWARTHMORE COLLEGE, May 19, 1898.